TALKING ELECTRONICS®

A NEW MAGAZINE FOR EXPERIMENTERS

$1.20*
N.Z. $1.40

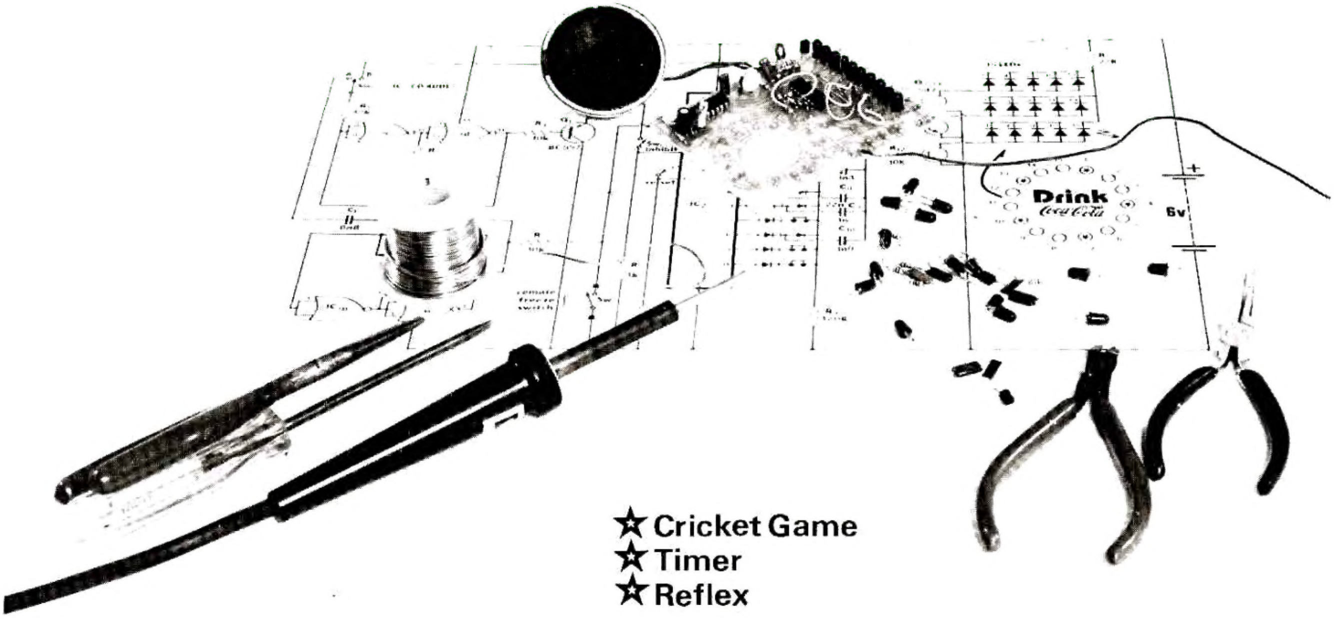
Issue No 3.

1 Amp Power Supply

Square Wave Oscillator

Binary Counter

The Experimenter Deck Continues....



☆ Cricket Game
☆ Timer
☆ Reflex

Counter Module

7 Segment Display

FREE TRANSISTOR OFFER P.31

Registered for posting as a publication – Category B

TALKING ELECTRONICS

Editorial...

Vol.1 No.3

With this third issue we have consolidated four of our main themes. You will notice our projects extend through a number of issues, becoming progressively more involved as they run and link up with other projects to produce a complex result; more complex than you would have accepted if it were presented individually.

Our circuit descriptions are very basic and are aimed at the beginner. In our field of digitals, the circuits do not come any simpler and we can only extend upwards and outwards from this ground plane. If you feel unfamiliar with some of the terms and terminology I suggest you join an electronics club. Electronics is so fulfilling you will find yourself eating, drinking and sleeping electronics. It can become your whole life. To become a competent electronics person, this is the way it must be. We are providing the ground plan. It is up to you to apply the data. Let's see.

Colin Mitchell.

Technical

–Craig Jones

Artwork

–Steven Babidge

Enquiries

10 Minute queries will be tackled on 550–2386

Advertising

–Bill Heath 550 2386

Publisher

TALKING ELECTRONICS is designed by Colin Mitchell at 35 Rosewarne Ave., Cheltenham, 3192. Articles suitable for publication should be sent to this address. You will receive full assistance with final presentation.

Printed Web offset by Std News @18,000 per 1½ hours!

Distributed in Australia by Gordon & Gotch.

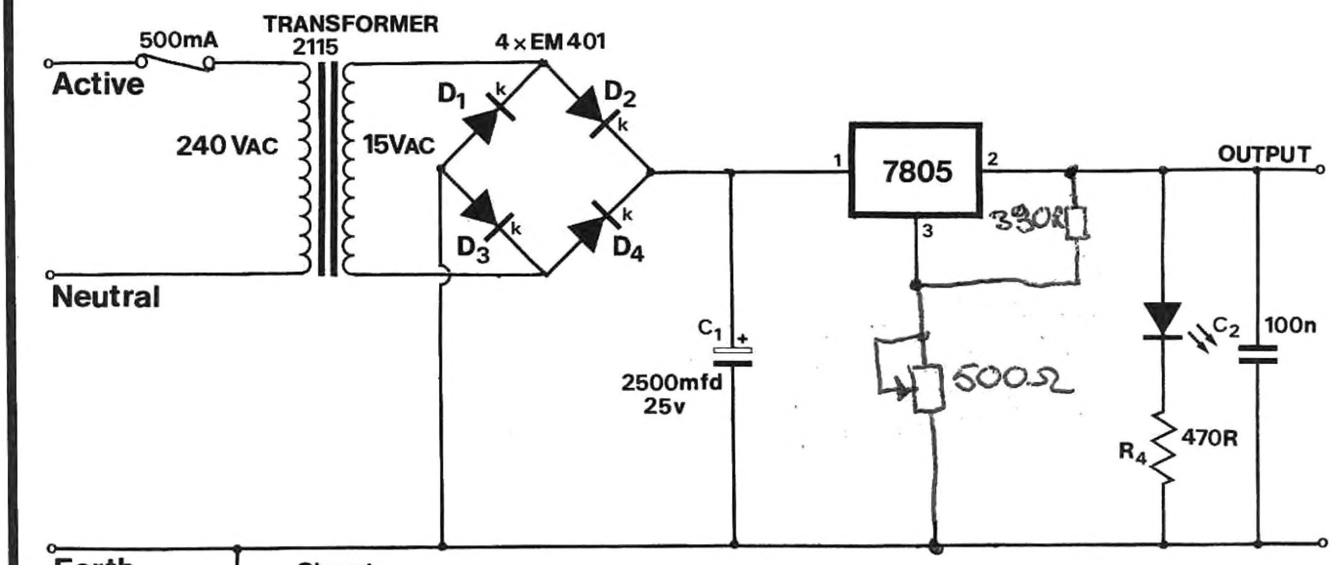
*Maximum recommended retail price only.

POWER SUPPLY by Ashley Emery

NOT TO BE CONSTRUCTED WITHOUT SUPERVISION

A fully regulated 1 Amp power supply suitable for our range of projects.....

PROJECT COST: $25



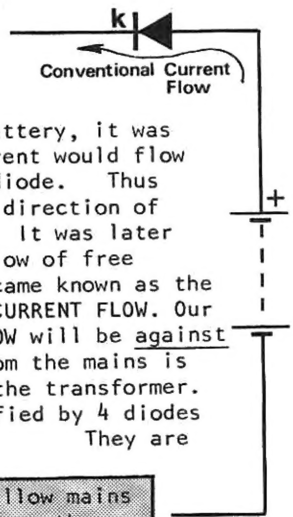
Regulated Power Supply Circuit

Our 1-amp power supply.....

If you take the Editors advice and build at least one project a month, you will soon realize how quickly you go through batteries. But don't be put off, build a fully regulated power supply.
As well as powering all the projects in this magazine, its voltages are suitable for powering items such as TV games, race car sets and calculators.
This power supply provides 4 useful fixed voltages: 5v, 6v, 9v and 12v; all at less than 100mv ripple, at full load current of 1 amp.
The 5v range is required for TTL projects and those calculators which use 3 penlite cells. It is important to keep the voltage below 6v for these circuits as the TTL IC's operate on a narrow voltage of 4.5v to 5.5v.
The maximum current capability of this power supply is 1 amp. If you happen to overload the output, don't worry, full overload protection is provided by the 7805 regulator.

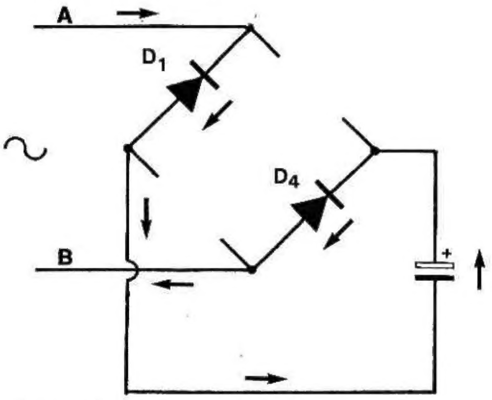
HOW IT WORKS

The operation of the circuit is very simple and can be explained with the aid of three diagrams. There are two ways of expressing the flow of electricity around a circuit. CONVENTIONAL CURRENT FLOW and ELECTRON FLOW. We will be considering the direction in which the electrons flow and it may look as if we have made a mistake according to the direction of the arrow on the diode. Unfortunately when the diode was invented, and its symbol introduced, the inventors of the day naturally thought electricity flowed out of the positive terminal of the battery and into the negative. This means that when a diode was inserted into a circuit with the anode lead towards the positive terminal of the battery, it was forward biased and the current would flow out of the cathode of the diode. Thus they drew the arrow in the direction of the supposed current flow. It was later discovered current was a flow of free electrons and the arrow became known as the direction of CONVENTIONAL CURRENT FLOW. Our description of ELECTRON FLOW will be against the arrows. The 240v AC from the mains is stepped down to 15v AC by the transformer. This voltage is then rectified by 4 diodes D_1 D_2 D_3 and D_4. They are

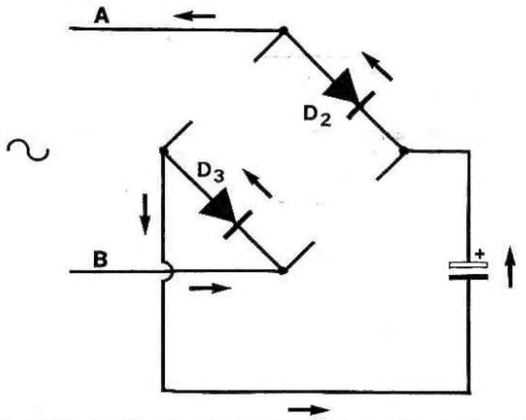


Few, if any, hobby clubs allow mains projects to be constructed as there can be a danger of faulty wiring producing a nasty shock. This project must be inspected by your teacher before turning it on.

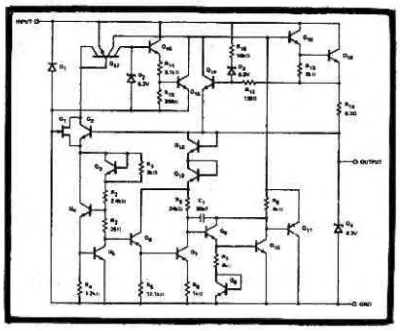
arranged as a "Bridge Rectifier". Although there are 4 diodes, only 2 are in operation at any one time. If we take the instant where the electrons are emerging from point A of the 15v winding, diodes D_1 and D_4 are the only two which allow the electrons to flow. Diodes D_2 and D_3 are reverse biased and have no effect on the circuit. The path becomes as shown in this diagram: The electrons are charging the 2500mfd electrolytic.



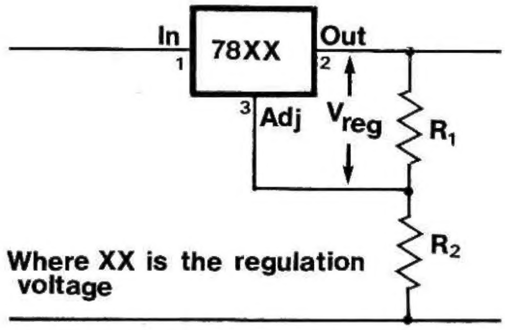
One half cycle later, the electrons are emerging from point B and diodes D_3 and D_2 are fully conducting, while D_1 and D_4 have no effect. This exchange takes place 100 times per second so that the 2500mfd electrolytic receives a small amount of energy in each ½ cycle.



For toys such as slot cars or train sets, this voltage would be sufficiently good enough. But for projects containing CMOS IC's and pulse circuits, the ripple contained within this DC voltage would cause false triggering. In addition we are designing a power supply which is variable from 5v to 12v. So to further smooth this voltage and accurately reduce it to 5v, we need a VOLTAGE REGULATOR. For this function we have chosen a 7805. It looks very much like an ordinary transistor and could very well be mistaken for one. It is a three-leaded device with pins labelled: IN, COMMON and OUT.



INTERNAL CIRCUIT (7805)



It is basically a 5v regulator but with clever circuit design, can be arranged to regulate to almost any voltage and still maintain the capacity to shut-down should the current rise to beyond about 1 amp. The two external resistors needed to provide this higher voltage can be obtained from the formula:

$R_1 = \frac{V}{.02}$ $= \frac{5}{.02}$ $= 250$ ohms.

R_1 is the resistor connected between pins 2 and 3.
V is the normal voltage of the regulator (in our case 5v)

Use a 500 ohm trim pot which can be adjusted down to 250 ohms.

$R_2 = \frac{D}{.025}$

R_2 is the resistor connected between pin 3 and ground
D is the difference between the normal output voltage of the IC and the required output voltage. In our case these are: 0v, 1v, 4v, and 7v.

The values of R_2 work out to be 0 ohms, 39 ohms, 150 ohms and 270 ohms.

QUESTION: Can you measure the output current of this regulated power supply by placing an ammeter across the output?

ANSWER: NO, definitely not! The power supply will see the ammeter as a SHORT-CIRCUIT and will shut down to give zero output. To overcome this, use a 20 ohm 10watt resistor in series with the ammeter on the 12v or 15v range and read the current flowing.

A LED (connected through a dropper resistor) is used as a POWER ON indicator and is placed at the output of the power supply to give an approximate visual indication of the voltage appearing at the terminals.
Normally this is the last place you would place a LED as the wide range in voltage would damage it. We have overcome this by providing a series resistor limiting the current to 20 ma on the 12v range. This means the LED will be just illuminated on 5v.
The 0.1mfd capacitor across the output reduces noise and spikes.

CONSTRUCTION

Assembling the power supply is relatively simple, but extra care is needed with the mains wiring and it is recommended that someone in authority check the wiring before switching on.
Begin construction by soldering the components onto the PC board. Care is needed when fitting the polarised components such as the diodes and electrolytics to avoid damage. Next wire the mains transformer and mains cord in accordance with the wiring diagram. When connecting the mains wires to the terminal block, make sure the active and neutral leads are well insulated from the case. The earth lug must be firmly attached to the case. Actually the earth lead should be the longest of the three leads and should never be stressed during assembly as it is required to be the last wire to break when the power lead is tugged. Connect 11 short lengths of hook-up flex to the PC board and follow the diagram for their terminations. For example: "A" on the PC board goes to "A" on the transformer. Use 9mm spacers to stand the board off the bottom of the case.

This project does not lend itself to being fitted into a plastic box as most commercially available boxes are not big enough to provide adequate ventelation. Providing a sufficiently large enough heatsink in a plastic box is also difficult. However a special ventelated box is available from A&R Soanar and has internal slots to take the heatsink.

HEATSINKING

If you intend to use this power supply to replace a small 9v battery in any of our projects, you will not need to heatsink the regulator IC. It's only when the power requirements near 200 - 300 ma on the 5v or 6v range that the IC will need to be kept cool.
A suitable heatsink is available from Dick Smith (Cat No H-3401 or H-3422). The IC is firmly bolted to it through a hole in the back of the case. If you are using a plastic case, the heatsink will be positioned inside the case. Make sure the leads of the IC do not touch the heatsink.

TESTING

Once construction is complete it is very wise to have the whole unit checked over and tested by a qualified person. The 500 ohm pre-set must be adjusted to 250 ohms. This can be done by simply setting the wiper to the mid position. Switch the unit on and test the output voltage with a voltmeter. Place a 22 ohm 5watt resistor across the output terminals and set the rotary switch to each of the four voltages. You will find the voltage will be within 0.5v of that specified.

PARTS LIST

1 - 39R ½watt 5%
1 - 150R " "
1 - 270R " "
1 - 470R " "
1 - 500R large vert. mount preset

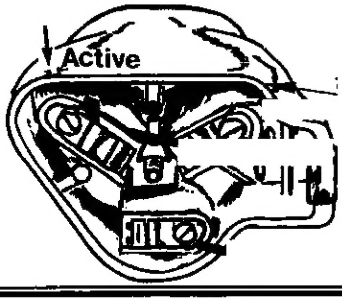
Capacitors:
1 - 0.1mfd greencap
1 - 2500mfd electro PC mounting

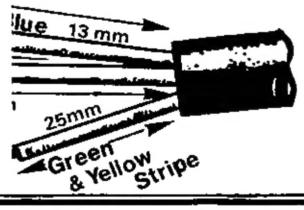
Semiconductors:
4 - EM401 1-amp silicon diodes
1 - 7805 5v regulator
1 - large RED LED.

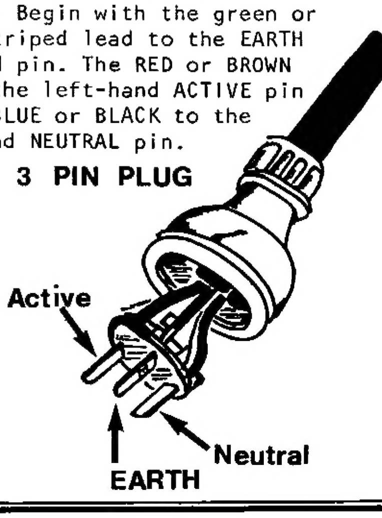
Miscellaneous:
1 - 2155 15v @ 1amp transformer
1 - fuseholder with 0.5amp fuse
1 - 3-way terminal block
1 - power cord with plug ← From: D.Smith
1 - 150mm x 76 x 134 metal case
1 - 75mm heatsink
1 - 240v SPST switch
1 - 3-pole 4-way rotary switch
1 - "Power supply" PC board
2 - banana plugs and sockets (one red, one black)
cable clamp, nuts and bolts, spacers, PC pins, solder lugs, grommet.

WIRING A PLUG-TOP

Take care when connecting up the plug-top. Begin with the green or yellow striped lead to the EARTH or plated pin. The RED or BROWN goes to the left-hand ACTIVE pin and the BLUE or BLACK to the right-hand NEUTRAL pin.

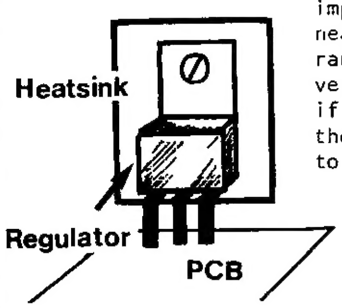




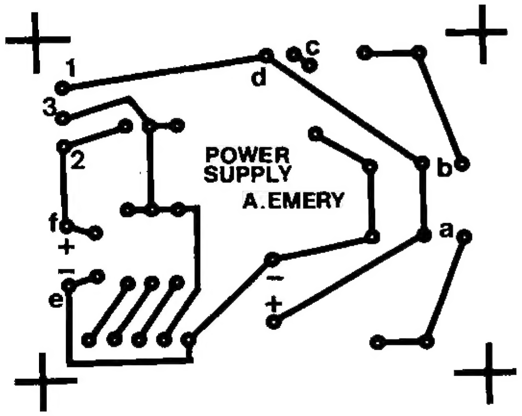


If you would like a continuously variable supply you can replace the rotary switch with a 500 ohm potentiometer and solder the middle tag to "J" on the board and the left-hand tag to "K". ("G", "H" and "I" can be omitted). This will give an output of 5 - 17v and it is recommended that a scale be fitted around the pot or connect a 20v panel meter across the output to give a visual indication of the voltage.

Back Panel



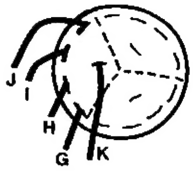
Mounting the regulator IC is only important when the demand is nearing 1 amp on the low voltage range. The leads of the 7805 are very delicate and will break off if flexed too many times. Leave the soldering of the regulator to last.



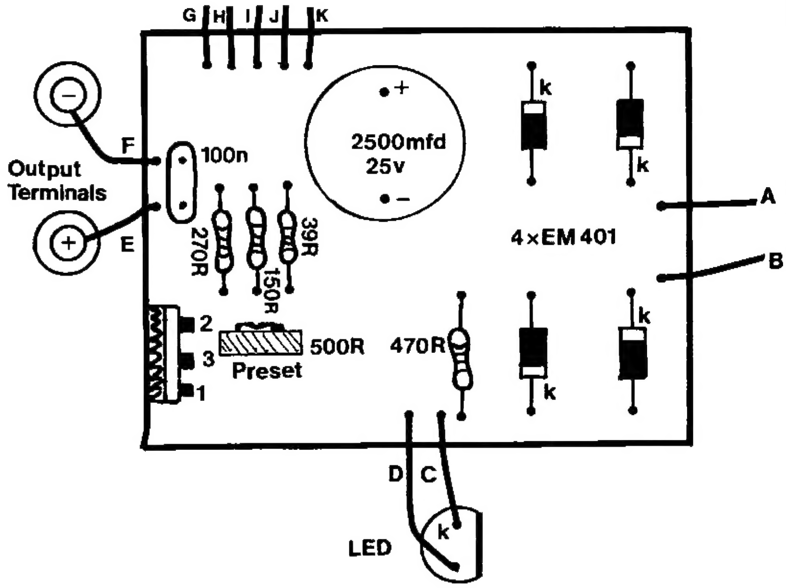
Use these layout diagrams to help you with assembling the power supply. Your own particular layout will depend on many factors such as the type of transformer, size of box and the shape of the fuse holder and switch.

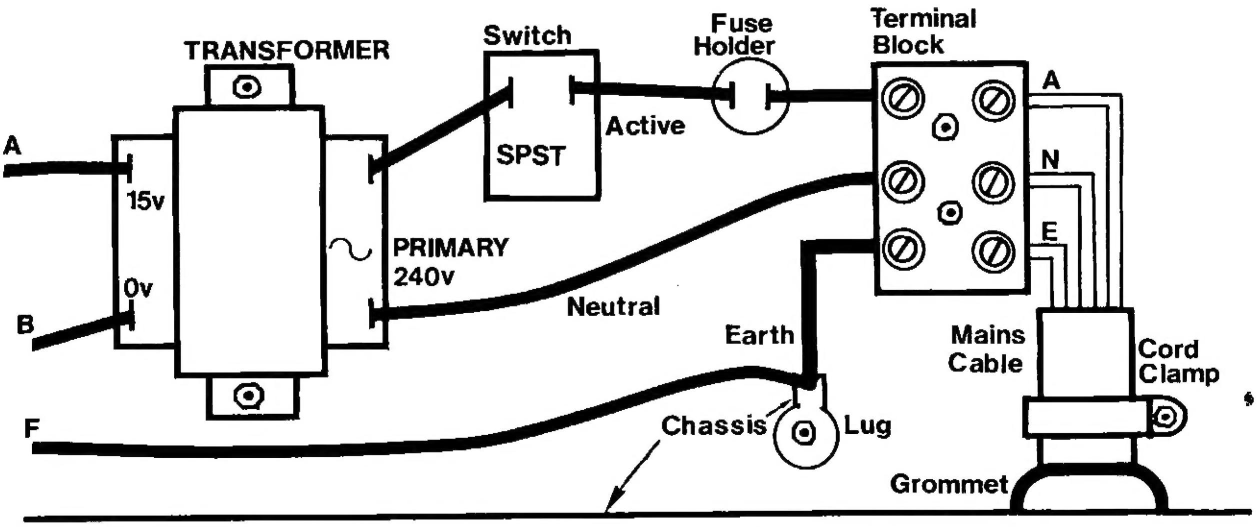
Do not use a double pole switch as you may wire it incorrectly and produce a short-circuit across the mains! Use a single pole switch in the active line so that you cannot make this mistake.

LAYOUT DIAGRAMS



ROTARY SWITCH (3 Pole, 4 Position)





Basic Electricity

AN INTERESTING 3 PAGES OF SIMPLE CIRCUITS TO TEACH YOU PARALLEL AND SERIES RESISTOR CONNECTIONS, OR TO BRUSH UP ON FORGOTTEN THEORY.........

THE ELECTRIC CIRCUIT

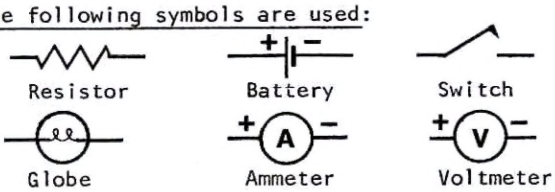
The term circuit in current electricity signifies the complete path through which an electric current passes.

Components needed to make a CIRCUIT:

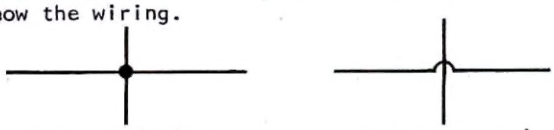
(a) A battery
(b) Conductors or wires to connect the battery to other circuit elements
(c) A load such as a globe, motor or resistor
(d) A controlling devise such as a switch
(e) A measuring instrument such as an ammeter or voltmeter

When drawing an electric circuit we represent each element by its symbol, which is a self-explanatory picture of the item. In the following electric circuits each item has a standard symbol.

The following symbols are used:

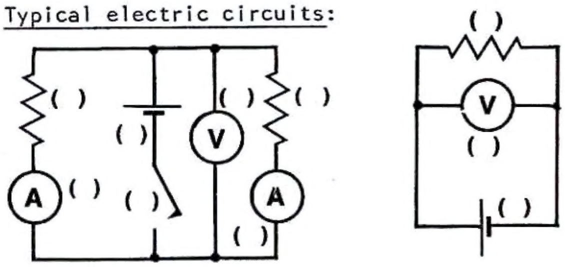


These are connected together with lines to show the wiring.

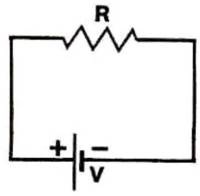


connected wires   not connected

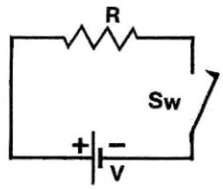
Typical electric circuits:



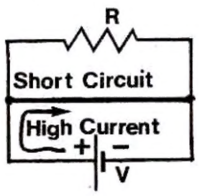
Fill in the brackets as follows:
(a) A battery............... write (1)
(b) Conductor or wire....... write (2)
(c) A load: e.g. resistor... write (3)
(d) Controlling device...... write (4)
(e) Measuring instrument.... write (5)



Closed Circuit exists when a current flows through each element of the circuit as intended.



Open Circuit exists when there is a break of very high resistance in the circuit such as a switch or broken wire.



Short Circuit occurs when a high current flows through an incorrect path in preference to the circuit elements.

OHMS LAW

In any simple circuit we can determine the value of current flowing through a resistor by the following formula:

$$I = \frac{V}{R}$$

where I = current in amps
V = voltage across the resistor
R = resistance in ohms.

Ohms law can also be written:

$$R = \frac{V}{I} \quad \text{or} \quad V = I \times R$$

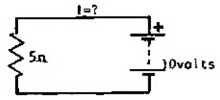
Note: When using the formula we must convert all our values to the basic units of volts, amps and ohms.

Thus:
200ma = 0.2 amps
3,000ma = 3amps
1kv = 1,000volts
2k2 = 2,200ohms
4M7 = 4,700,000ohms = 4.7×10^6

Convert the folowing to basic units:

(i) 5ma
(ii) 2,340ma
(iii) 10Kv
(iv) 3.47M
(v) 0.1Kvolts
(vi) 0.02Meg ohms
(vii) 5,300ma
(Viii) 680ma

Examples using Ohm's Law:



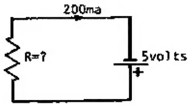
$I = \frac{V}{R}$

$= \frac{10}{5}$

$= 2amps$

What is the value of I?

Example 2.



Note: 200ma =.2amp

By Ohm's Law:

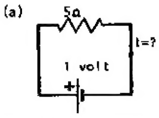
$R = \frac{V}{I}$

$= \frac{5}{.2} = \frac{50}{2}$

$= 25ohms$

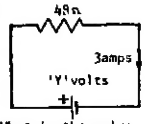
Problems:

(a)



What is the current flowing in fig. (a)?

(b)

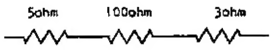


What is the value of 'Y'?

RESISTANCES IN SERIES

For resistances in series the total resistance is the SUM of their values.

e.g.



Total = 5 + 100 + 3
= 108 ohms.

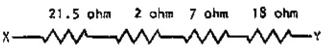
In general:

$R_{total} = R_1 + R_2 + R_3 + R_4 + \ldots\ldots$

Example 1.

What is the resistance between A and B?
Total resistance = 8 + 15 + 7
= 30 ohms.

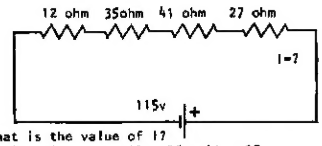
Problem.



What is the total resistance between X & Y?

R_t = ___ ohms

Example 2.



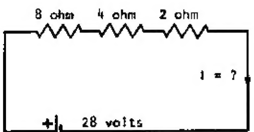
What is the value of I?
Total resistance = 12 + 35 + 41 + 27
= 115 ohms

$I = \frac{V}{R}$

$= \frac{115}{115}$

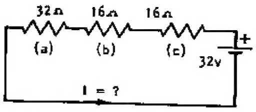
$= 1$ amp

Problem:



What current is flowing in the circuit?

In a series circuit such as:



The voltage across each resistor can be found from:

$E_{(a)} = I \times R_{(a)}$

where I is the same for the three resistors in a series circuit.

Current flowing:

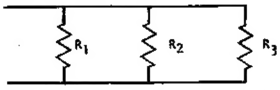
$I = \frac{E}{R} = \frac{32}{64} = 0.5$ amp

$E_{(a)} = I \times R_{(a)}$
$= 0.5 \times 32$
$= 16$ volts

Question: What is the voltage across each 16 ohm resistor?

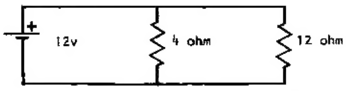
RESISTANCES IN PARALLEL

For resistors in parallel the equivalent single resistance if found from the following equation.



$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots\ldots$$

Example 1.



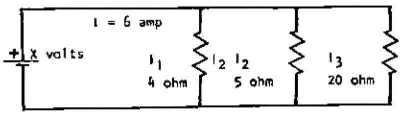
$\frac{1}{R_{total}} = \frac{1}{4} + \frac{1}{12} = \frac{12 + 4}{48}$

$= \frac{16}{48}$ $\quad \frac{R}{1} = \frac{48}{16} = 3$ ohm

This shows that two parallel resistors can be replaced by a single resistance of 3 ohms.

Example 2.

A current of 6 amp divides between resistances of 4 ohms, 5 ohms and 20 ohms connected in parallel. Calculate (i) The voltage across the combination. (ii) The current flowing in each resistor.



Let R be equivalent resistance.

$\frac{1}{R} = \frac{1}{4} + \frac{1}{5} + \frac{1}{20}$

$= \frac{5 + 4 + 1}{20}$

$= \frac{10}{20}$

$\frac{R}{1} = \frac{20}{10} = 2$ ohms

Now: from Ohms Law, the voltage across the resistors:

$V = I \times R$

$= 6 \times 2 = 12$ volt

The voltage of 12volt appears across each resistor.

Current flowing in 4 ohm resistor:

$= \frac{V}{R} = \frac{12}{4} = 3$ amps

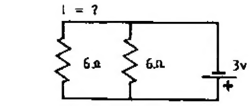
Current in 5 ohm resistor:

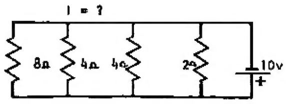
$= \frac{V}{R} = \frac{12}{5} = 2.4$ amps

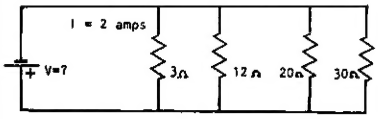
Current in 20 ohm resistor:

$= \frac{V}{R} = \frac{12}{20} = 0.6$ amps

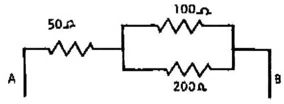
Problems:







COMBINED PARALLEL & SERIES CIRCUITS



What is the resistance between A & B?

Resistance of a Parallel combination:

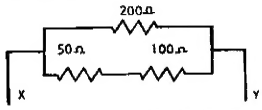
$\frac{1}{R} = \frac{1}{100} + \frac{1}{200}$

$\frac{1}{R} = \frac{3}{200}$

$\frac{R}{1} = \frac{200}{3} = 66\frac{2}{3}$ ohms.

Total resistance between A & B
= 50 + 66.6
= 116.6 ohms.

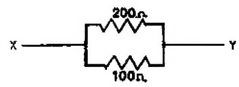
Example:



What is the resistance between X & Y?

Resistance of 50ohm + 100ohm combination = 150 ohms

Circuit becomes:



$\frac{1}{R} = \frac{1}{200} + \frac{1}{150}$

$= \frac{3 + 4}{600}$

$\frac{R}{1} = \frac{600}{7}$

$= 85\frac{5}{7}$ ohms

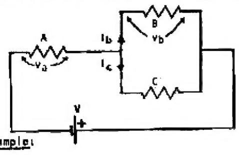
WORKING SPACE:

Points to REMEMBER in Series - Parallel Circuits:

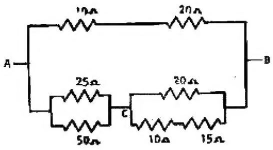
(1) $I = I_b + I_c$

(2) Voltage across B = voltage across C.

(3) Voltage across resistor A plus voltage across B equals battery voltage. $V_a + V_b = V$



Example:



Solution:

(1) Solve 25 ; 50 parallel pair.

$$\frac{1}{R} = \frac{1}{25} + \frac{1}{50}$$

$$= \frac{2 + 1}{50}$$

$$\frac{R}{1} = \frac{50}{3}$$

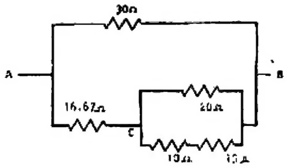
$$= 16.67 \text{ ohms.}$$

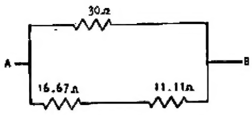
(2) Resistance between CB:

$$\frac{1}{R} = \frac{1}{20} + \frac{1}{25}$$

$$= \frac{5 + 4}{100}$$

$$\frac{R}{1} = \frac{100}{9} \quad 11.11 \text{ ohms.}$$





(3) Resistance of lower branch:

$= 16.67 + 11.11$

$= 27.78$ ohms.

(4) Total resistance between A&B

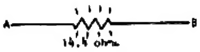
$$= \frac{1}{30} + \frac{1}{27.78}$$

$$= .0333 + .036$$

$$\frac{1}{R} = \frac{.0693}{1}$$

$$R = \frac{1}{.0693}$$

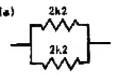
$$= 14.4 \text{ ohms}$$



Unfortunately we seldom find resistors of 20 ohms, 30 ohms 50 ohms as these we only used to keep the problems simple. Most of our circuits use standard value components such as 2k2 or 10k resistors.

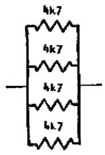
Try these: Find R: -

(a)

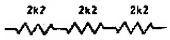


(b)

(c)



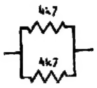
(d)



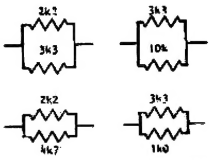
In the previous question, did you notice the answers were: (a) half the 2k2 resistance, (b) twice the 3k3 resistance, (c) one quarter the 4k7 resistance and (d) three times the 2k2 resistance.

This give us a quick way to evaluate an answer without the need for a formula. It only works if all the values are the same.

Mentally evaluate these problems:



If resistors of equal value are not used, you will need to use the formula.



Remember: The answer to a parallel combination is always less than the smallest resistor.

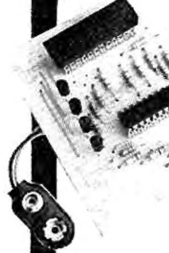
Answers in SHOP TALK

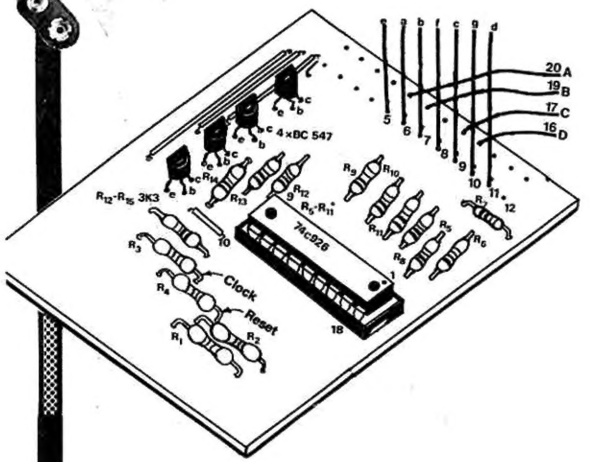
Connecting the

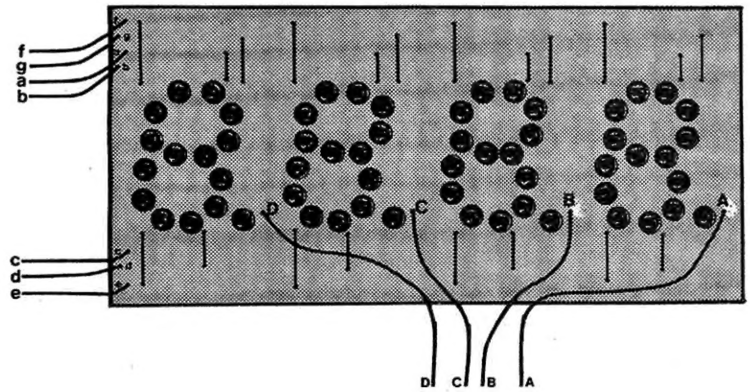
COUNTER MODULE TO 7-Segment Display

– Craig Jones

Project cost: $12 + $10







2.5cm READOUT

If you require a large display, one which can be read from a distance of 3 - 15 metres, you can combine the COUNTER MODULE with the 7-SEGMENT DISPLAY. We have provided Molex pins on the PC board to enable the "AND" display to be easily removed and replaced by any display of your choice. When it is removed, the connections between the two boards are made via flying leads, fitted into the holes 5 to 11 and 16, 17, 19, 20. The Molex pins are best removed as they are not very rigid and can be bent over and create a short to the next-door pin. We need 2 widths of rainbow cable to connect the home-made 7-segment display to the counter. One lead contains 4 wires, the other 7 wires. The first cable fits into holes 16, 17, 19, 20 and connects directly to the cathodes of the digits A,B,C,D. The other cable fits into holes 5,6,7,8,9,10,11 and connects to the segment rails a,b,c,d,e,f,g. To keep the wiring simple we have not included any decimal points. The 7-segment letters appear at the end of the PC board and run the length of the display to link up with each digit via jumpers on the board. The 7 core ribbon will need careful wiring at the display end as the lettering on the display does not correspond directly with the module and will have to be criss-crossed before soldering to the lands. The other end of the ribbon cable will need to be prepared by tinning before soldering into the PC board holes.
The diagram shows which pins correspond to the segment outputs and which pins provide the digit outputs.

Mounting

Lay the assembled display on to P19 of issue 2 and you will find it fits neatly into a Zippy box type UB3. (What a handy idea, having the full range of box sizes for reference!)
The lid of the UB3 box should be replaced by a thin sheet of red perspex to highlight the illuminated LEDs and completely camouflage the other LEDs. The red screen improves the clarity of the illuminated display immensely. Glue plastic standoffs onto the display and mount it just behind the perspex screen with silicone sealant. Bring the rainbow ribbon out the side of the box. This lead can be as long as needed so the readout can be mounted at any distance and any height depending on its intended use.
You can also use 12-core Telecom wire for this interconnection. (Available from Dick Smith Cat. W 2140).

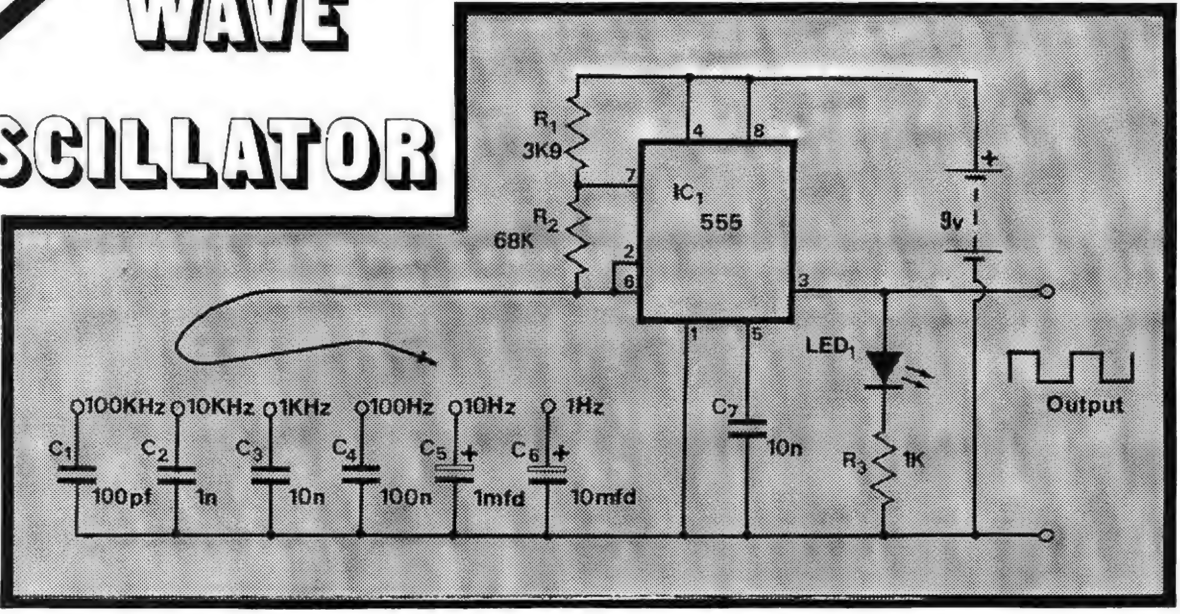
If you experience difficulty obtaining the 74C926, you can substitute it directly with two other chips. They all have identical pin-outs. But they do not give the same counting up to 9999 as they are designed for slightly different purposes. However these differences may fall in line with your requirements. The maximum readouts of the three IC's are as follows:

74C926:	9999
74C927:	9599
74C928:	1999

You will notice the 74C927 is designed to be used as an elapsed timer. The first digit indicates hours, the next two digits give minutes and the fourth digit indicates tenths of a second.

SQUARE WAVE OSCILLATOR

A SELECTABLE SQUARE-WAVE OSCILLATOR IS A VERY HANDY PIECE OF TEST EQUIPMENT. MANY OF OUR PROJECTS REQUIRE "CLOCKING" AND THIS OSCILLATOR PROVIDES SIX FREQUENCIES.



SQUARE-WAVE OSCILLATOR CIRCUIT

The heart of our circuit is a 555 timer. It is capable of precision timing and has drift values somewhat better than its surrounding parts!
We have seen the 555 timer before but a re-cap of its versatility and characteristics will be invaluable if you wish to alter the circuit.
Using a 555 produces an inexpensive project which is self-contained and can be connected and finished or partly finished project you wish to test. We have tried to obtain a decade readout between each frequency using standard components to give a 10:1 increase with each stage. This gives a universal coverage suitable for slow clocking through to a fairly high operational speed. The advantage of a slow clock from an oscillator in preference to a switch means the elimination of bounces and spikes.
The layout of the board lends itself to the addition of any special frequency you may choose or merely provide a selection of two or three frequencies. It all depends on how many capacitors you include. At a slow clock rate, this oscillator will help you determine if an IC is clocking on the rising edge of the waveform or the falling edge. This knowledge is essential when designing a circuit with a number of IC's which are required to be in synchronisation from one clock source.
If you don't understand these terms, wait for issue 5.

The project can be mounted in a small Zippy box to protect it from rough handling. When connecting the battery, you will need to add a switch as the 555 draws about 10ma during quiescent conditions. The LED draws about 8ma or about 4ma average on a 50% duty cycle waveform, making a total of about 15ma. The frequencies are selected via a flying lead that fits into one of 6 molex pins. This saves expensive switches and keeps the project compact.

Timing periods are virtually independent of rail voltage. They are set by the time taken for the timing capacitor to charge to 2/3 of the supply voltage then discharge to 1/3 of the supply voltage and recharge to 2/3 the supply voltage again ad infinitum. Since the 68k resistor is the main resistor controlling this charging and discharging, we can see that these two periods will be almost equal. (The fact that the 3k9 is added to the 68k during charging will make very little difference to the charge time.) To understand how the 68k charges and discharges the capacitor, we must look into the operation of the 555 IC.
When the supply is connected, the capacitor begins to charge. When its voltage rises to 2/3 of the supply voltage, this is detected by pin 6, transferred to the comparitor inside the IC, to connect pin 7 to the negative rail. This causes the capacitor to discharge through the 68k resistor to a point where it is 1/3 of the rail voltage. Pin 2 detects this, removes the short on pin7 to allow the capacitor to charge up again.

555 NOTES

Here are some helpful notes for future circuit designing.

The output of the 555 is capable of sourcing (supplying) a maximum current of 200ma and can sink (absorb) the same current.
This makes it suitable for driving loads such as relays and LEDs without the need for a buffer transistor. In the astable (or free-running) mode as shown in the circuit diagram, the 555 triggers itself and the timing capacitor charges through R_1 and R_2 and discharges through R_2 only. By adjusting these resistors, the duty cycle can be precisely set.

The Duty cycle "D" is given by:

$$D = \frac{R_b}{R_a + 2R_b}$$

Putting **R** values into the formula

we obtain: $$\frac{68,000}{3900 + 136,000}$$

$$= \frac{68}{139.9}$$

$$\therefore D = 50\%$$

In this formula, you can see the top resistor R_a has such a low value with respect to R_b that it has very little effect on the duty cycle.

The frequency of oscillation of the 555 timer follows this formula:

$$f = \frac{1.44}{(R_a + 2R_b)C_1}$$

If we take the values for the slow clock rate and insert them into the formula,

we obtain:

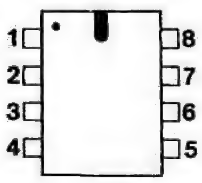
$$f = \frac{1.44}{(3900 + 136,000)10\times10^{-6}}$$

$$= \frac{1.44}{1.399 \times 10^5 \times 10 \times 10^{-6}}$$

$$= \frac{1.44}{1.399}$$

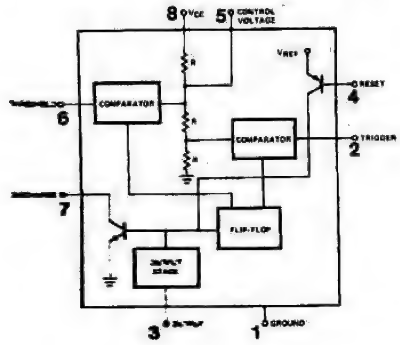
= approx 1Hz

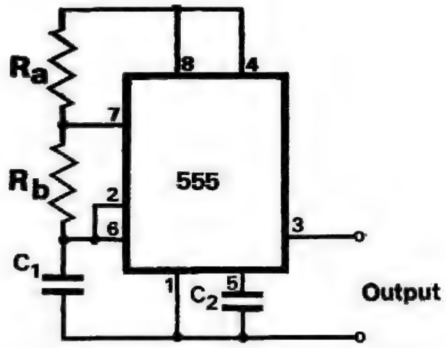
555 PIN-OUT



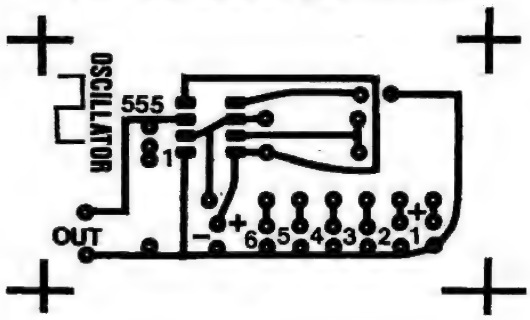
1 Ground
2 Trigger
3 Output
4 Reset
5 Control Voltage
6 Threshold
7 Discharge
8 V_{cc}

555 BLOCK DIAGRAM





PC ARTWORK (not full size)



PARTS LIST

R1	resistor	3k9	¼watt
R2	"	68k	"
R3	"	1k	"
C1	capacitor	100pf	100v
C2	"	1n	"
C3	"	10n	"
C4	"	100n	"
C5	electrolytic	1mfd	16v
C6	"	10mfd	"
C7	capacitor	10n	100v
LED_1	3mm or 5mm	Red LED	
IC_1	TIMER	NE 555	

battery snap — 6 molex pins
9v battery — hook-up flex
hook-up wire — IC socket

"SQUARE WAVE OSCILLATOR PC BOARD"

DECIMAL NUMBER:	BINARY NUMBER:
0	00
1	01
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111
16	10000
17	10001
18	10010
19	10011
20	10100
21	10101
22	10110
23	10111
24	11000
25	11001
26	11010
27	11011
28	11100
29	11101
30	11110
31	11111
32	100000
33	100001
34	100010
35	100011
36	100100
37	100101
38	100110
391	100111
40	101000
41	101001
42	101010
43	101011
44	101100
45	101101
46	101110
47	101111
48	110000
49	110001
50	110010
51	110011
52	110100
53	110101
54	110110
55	110111
56	111000
57	111001
58	111010
59	111011
60	111000
61	111101
62	111110
63	111111

....Continuing the

EXPERIMENT

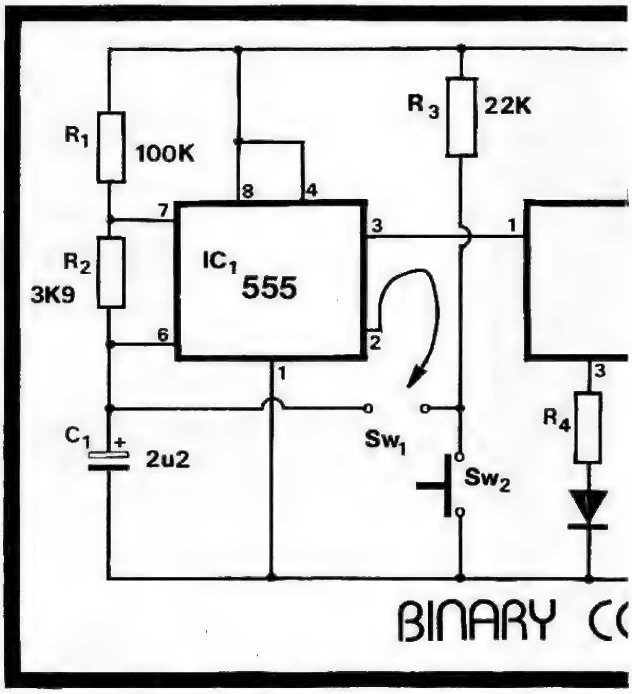
PROJECT SEVEN

BINARY CO

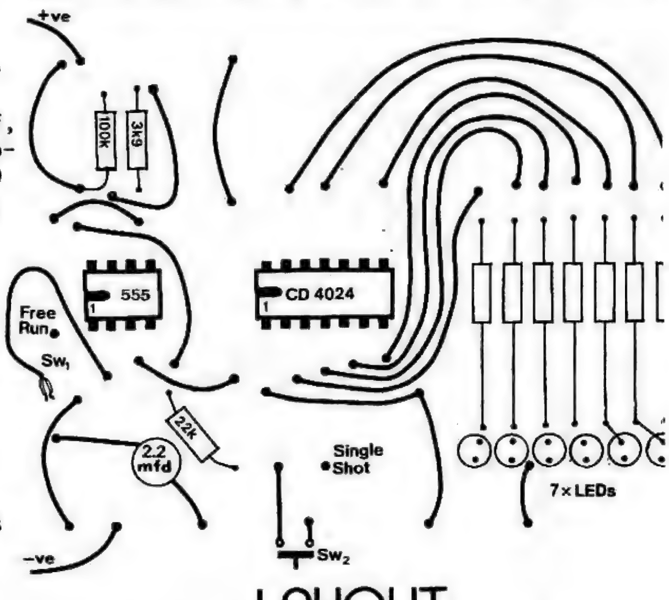
A BASIC 7-STAGE COUNTER TO TEACH BINARY. AND DOUBLES AS A VISUALLY EYE-CATCHING DISPLAY.

The next stage in this series involves learning the Binary Table. You may ask, "What is the necessity of a Binary Table?" What's wrong with our 0-9 numbering system? The answer is quite simple. Digital electronics produces voltages which are either HIGH or LOW. They are not designed to give "half-on" or "quarter-off" situations as these are indeterminate values. How would you tell when the output of a circuit is half ON and not 45% ON? Digital electronics is in essence an exact science. There are no "in-between" voltages. Under these conditions the circuit will be suitable to drive a LED accurately. The LED will respond by being either fully ON or completely OFF. This means a LED can never be half ON, so visual interpretation will not be required to read the value. The LEDs in the output of our circuit are required to represent numbers. We could do this in two ways: Allocate one LED for each number if we wish to count up to 20 or 30, however a very large display would be created if we wished to count to 100 or 500. Another, and more practical, method is to program the LEDs to represent a particular value when lit. The simplest method of achieving an easily readable display has already been designed. It is called a BINARY DISPLAY. The word binary is derived from BI- meaning 'two', and each LED is designed to be read in either of its two reliable states: ON or OFF.

Suppose we set up a row of 7 LEDs. As with ordinary columns of numbers, the digit in the right-hand column represents the smallest number or "units". The same applies with the BINARY TABLE. When this LED is off, it represents zero. When illuminated it represents ONE. To represent TWO, the next LED will light and the first LED will be OFF. Obviously a three will require both LEDs to be ON. Using two LEDs we can count to only three. The next LED will represent a FOUR. This allows us to count to seven. (1 plus 2 plus 4). The binary system uses more readouts than conventional decimal notation however it is a form which can be directly coupled to an electronic circuit to see exactly what is happening within. Can you imagine trying to interpret a LED which is supposed to be illuminated 40%? This would be absolutely impossible as LEDs give off varying intensities according to their batch number or quality rating. Luckily this does not concern us in the BINARY TABLE



BINARY C(



LAYOUT

JUNIOR PUZZLE PAGE

★ This page provides the very beginning into ELECTRONICS. You can't get anything more simple. Any contributions for this page will be welcome.

CAN YOU SEE ANYTHING WRONG WITH WITH THIS SENTANCE?

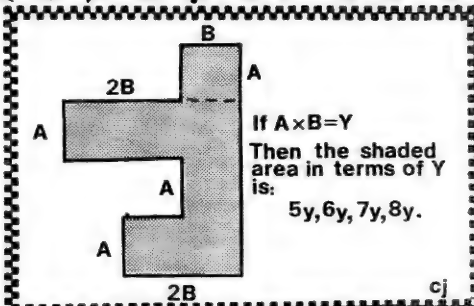
PROTECTING TRANSISTORS:

Match these words to the 6 diagrams: HIGH VOLTAGE, HEAT, MECHANICAL SHOCK, MOISTURE, INCORRECT BIAS, BRIGHT LIGHT.

If a transistor costs a dollar and a half, and you get half a transistor change, what is the cost of 3 transistors?

The border of this page is made up of capacitors and diodes. But there is one small mistake. Can you find it?

Here is a puzzle I found among some old papers: A radio is built onto a narrow printed circuit board. The three major sections are: THE FRONT END, IF STAGE, and POWER AMPLIFIER. The front end is 8cm long. The power amplifier is as long as the front end and half the IF stage. The IF stage is as long as the front end and power amplifier together. What is the length of the radio strip?



If A×B=Y

Then the shaded area in terms of Y is:

5y, 6y, 7y, 8y.

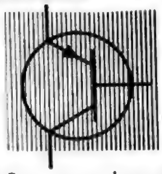
ELECTROWORD

P. Watt 3154

FIND THE HIDDEN ELECTRONIC WORDS. THEY MAY BE SPELT VERTICALLY, HORIZONTALLY, BACKWARDS OR DIAGONALLY. HERE IS A LIST OF THE WORDS:

AND	DATA	INVERTER	OR
BATTERY	DIGITAL	LED	OUTPUT
CAPACITOR	DIODE	NAND	RESISTOR
CHIP	ELECTRONICS	NOR	TALKING
CIRCUIT	INPUT	NOT	TRANSISTOR

Z	O	Y	N	X	I	O	T	P	C	I	R	C	U	I	T	Y
D	C	A	N	D	N	D	P	A	A	T	E	O	T	T	I	E
B	F	Y	A	X	M	O	A	O	R	E	O	S	N	I	D	E
O	E	O	N	E	G	A	N	T	I	N	V	E	R	T	E	R
A	T	E	D	K	B	O	S	N	A	N	C	A	T	A	O	O
T	A	L	K	I	N	G	O	O	B	O	T	H	O	T	T	Y
A	L	E	O	E	O	N	O	R	Z	T	I	O	I	I	O	R
E	T	C	O	B	Y	A	N	O	E	I	E	P	I	P	O	E
E	E	T	N	Y	A	M	R	O	T	S	I	S	N	A	R	T
T	I	R	E	E	D	O	I	D	Z	A	I	O	A	E	E	T
U	E	O	Y	D	O	I	K	B	I	B	A	S	E	O	A	A
P	N	N	O	A	G	O	G	L	Y	L	O	R	T	A	R	B
N	I	I	H	E	A	T	S	I	N	K	N	O	T	O	O	A
I	N	C	H	O	U	T	P	U	T	I	A	Z	A	M	R	Z
G	I	S	C	O	G	U	E	O	E	A	K	O	U	Y	A	C
R	O	T	I	C	A	P	A	C	D	E	L	Z	B	G	O	A



Can you decode this noisy picture: ???

TECHNICAL WRITING

Technical writing is an art. It requires the combining of three talents. Correct expression, an understanding of electronics, and an exciting presentation.

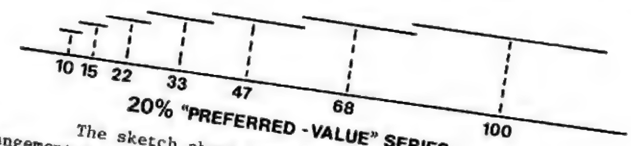
Just as you master electronic circuitry by experimentation, the written aspect must also be learnt. In each issue we will feature an article on technical writing. As with electronics, it will have to be actually physically attempted, to benefit you. This month we start with a short article on PREFERRED VALUES. It is reproduced here and attempts to explain a quite simple aspect of electronics. The origin and its author don't concern us. We don't want to be critical of the author but use his efforts as a basis to mastering better writing.

Firstly I suggest you read through the article. To me, it was quite confusing and left me no better informed. It falls down on three sides. Apart from the technical inaccuracies, it is mainly the phrasing of the sentences which I wish to restructure with you. The writing is hard to read, fails to convey the message and doesn't have any flow. We will go through the article paragraph by paragraph and improve the grammar. At the end of this article you will be required to write and improved version of "PREFERRED VALUES" in you own words.

Have you ever wondered why the values of components such as resistors, capacitors and even some inductances are given in what appear to be odd numbers such as 22, 47, 68 and so on? Actually the numbers are very carefully chosen, and are part of a system of what are called "PREFERRED VALUES".

In the early days of radio the values of components were given what might seem to be normal values, 10, 20, 30 and so on. But if we look at these values we see they are not very logical after all. If we look at the older series of values we see that the first two, 10 and 20, go up by 100%.So with 20% tolerance components there is a large gap - between 12 and 16 - where there is no value available. At the other end, 90 to 100, we find that a low value minus 20 % gives 80, while the 90 plus 20% gives 108. So we have the silly situation where a low value component can be lower than a 90 value component.

So the manufacturers of components decided to make a more logical system, where the next value began where the previous one stopped. With a 20% tolerance the 10 value could vary from 8 to 12, so the next value was chosen as 15. The bottom value tolerance of this would be 12, which is the top tolerance of the 10 value. The top tolerance of the 15 value would be 18, so the next value chosen was 22, where the bottom tolerance would be 17.6 - very nearly the same as the top tolerance of the 15 value. And so the series goes on 10, 15, 22, 33, 47, ·68, 100 and so continues always going up by the same ratios. If we want more accurate tolerances, say 10% or 5% then we have intermediate values based on the same principle.



20% "PREFERRED - VALUE" SERIES

The sketch above shows how the components with this new arrangement cover the full range without overlapping, and they all have the same 20% tolerance. Apart from avoiding the situation that was mentioned above where a 90 value high-tolerance component could be higher than a 100 value low tolerance component there is the big advantage that instead of needing nine different values to cover the range we now only need six. This is particularly helpful where a firm is dealing with stocks of many thousands of components.

Always commence with a short sentence. Short sentences are fast reading. They spur the reader on. A sentence should contain only ONE idea. The first sentence is too long. Break it into two, something like this:

Have you ever wondered why resistors have 22, 47 or 68 on them? They appear to be such odd numbers. Actually they have been very carefully chosen, and are part of a system called "PREFFERED VALUES".

Notice he has two 'whats' in the first paragraph. NEVER USE "WHAT or THAT". In the second paragraph we must remove the word 'what'. The sentence becomes:

....components were given seemingly normal values of 10, 20, 30 and so on.

The remaining part of the paragraph is extremely difficult to follow as there is no introduction to how he arrived at his figures. It would be necessary to include a few additional sentences to explain this more thoroughly. However the most glaring fault with the paragraph lies in his use of the 20% tolerance range. This range went out with radio sets in the 1950's! I don't think a 20% resistor has been made for the past 30 years! Maybe it is a simple analogy to use, but if you are talking technically to beginners, they can just as easily comprehend an up-to-date manufacturing code, as a 30 year old code. I would suggest the 2% or 5% range but let's standardize on the well-know 10% range.

As with all manufacturing processes, the manufacturer does not want to waste any of the components. This means there must be a reasonable deviation either side of the spot-on value, which must also be accepted. Resistors are no exception. They are made in a continuous process in which the operator is aiming at say a 1k resistor. If you were to test these, you would find some could measure as high as 1.5k and others as low as 500 ohms. (This is only an analogy. In practice they would not deviate to this extent).

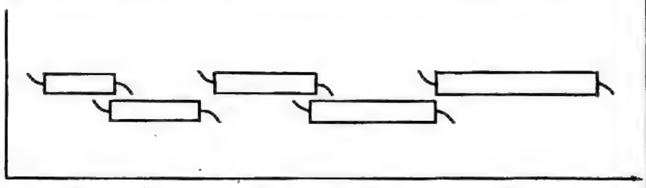
Any values outside this range may indicate a particularly bad fault in the end-termination or moulding or cutting process. In this case the machine would be stopped and corrected. Let us suppose all the components lie in the range stated above.

The point brought out in the second paragraph is valid. Continue along the same lines with a 10% range. Refer to data sheet No1. for the preferred values from 10 ohms to 100 ohms. The third paragraph should also be re-worded using the 10% range. Begin something like this:

The manufacturers of components decided to make a more logical system; without any overlapping, waste or missing values. The answer lay in an easy-to-understand 10% tolerance system. If the first value selected is 10, the top tolerance would be 11. The next value would need to have its lower tolerance very close to 11. This value would be 12. Now continue on... Just extend this reasoning up to 15 or 18.

Above the third paragraph is a sketch or graph. Its main fault lies in the ascending heights of the bars. These have no relation to the graph and are mis-leading. It is always an advantage to make the graph into a pictorial such as a circular graph (Pie Graph) or cutting up a component such as a map or dollar sign into pieces, to carry your message more clearly and more rapidly.

My suggestion for a 10% PREFERRED VALUE CHART is this:



Re-write the third paragraph without using the word 'that'. Tidy up all your sentences and make sure they flow from one to another. Keep the theme consistent in each paragraph. Round off the article with one last concluding sentence. Your final versions need not be sent in to us. In fact, we wouldn't know how to cope with five hundred essays! You will merely have to keep them tucked into the back of the magazine and refer back to them at a later date; to see how much you have progressed.

Contributions to these pages will be most welcome, either of the original variety or a composite article with technical improvements.

series

ER BOARD

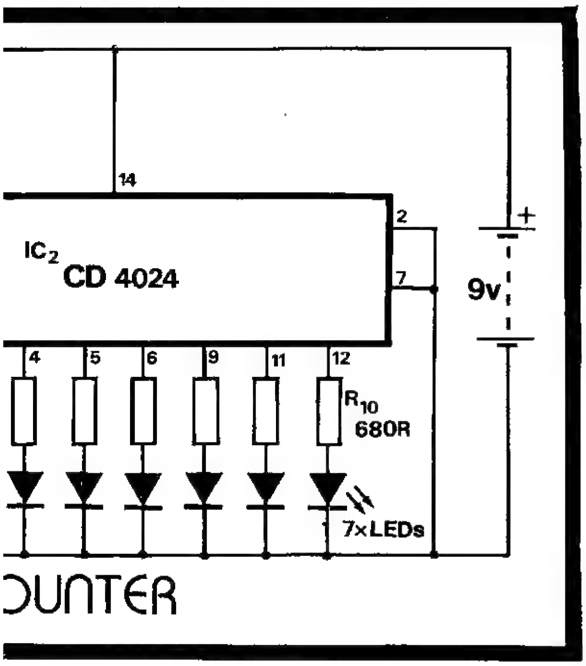
UNTER

J.Petroulias

IT

After building project six

Project cost: $3.50



Parts List

R1	resistor	100k	¼watt
R2	"	3k9	"
R3	"	22k	"
R4 to R10	"	680R x 7	
C1	electrolytic	2.2mfd	16v
IC1	timer IC	NE 555	
IC_2	binary counter	CD 4024	
LED_1 to LED_7	large red LEDs		

battery clip
9v battery
push-to-make switch
molex pin
hook-up wire

"Experimenter Board 3-ICs"

Circuit Operation

The 555 and its associated components form an astable multivibrator with a frequency of about 2Hz(1 pulse every ½second). Depending on the position of Sw_2 the counter will receive auto pulses or manual pulses. R_1, R_2 and c_1 set the frequency for the "clock". The 555 has also been arranged as a one-shot with triggering from Sw_1.
When Sw_1 is pressed, the short on pin 7 is removed via the internal working of the 555 and capacitor C_1 begins to charge. As the voltage rises to 2/3 of the supply voltage, pin 6 detects this and cycles the 555 to produce a single pulse for the 4024 IC. At the same time pin 7 becomes connected to ground and the capacitor begins to discharge through R_2. A portion of this discharge time forms the maximum cycling rate for the 555, so no matter how fast the push-button is pressed, the clocking rate will be a max. of about 2Hz. This circuit is not designed for interpreting high-speed input pulses, and should be kept for low-repetition manual operation.
The intention is for you to input a specified number of pulses and read off the result from the illuminated LEDs. You can check any value from the complete table on either side of the article. This is an ideal aid for learning the BINARY TABLE.

Assembly

Some of the components from project six can be left in place, others will have to be removed or re-positioned. Follow the lay-out diagram for the position of each component. Fit all the jumper wire first, then the components and finally the IC. Switch the game to auto, connect the battery and the IC will start to count.
Once you have mastered the BINARY TABLE, or have sufficient understanding to be able to make your own, you can use the project in the auto mode for a visually pleasing display.

Making Sw 1

The change-over switch Sw_1 selects either auto or manual clocking. It is made from 2 molex pins and a flying lead. Since this switch is used on very few occassions, the molex pins will be quite sturdy enough.

Problems

Pulse your counter 28 times and read the LEDs. Confirm your answer from the table. Try these: 57pulses; 89pulses; 102pulses; 128pulses; 152pulses. What do you notice about the last two?

Can you find the mistake in the BINARY TABLE running down the outside edges of this page.

DECIMAL NUMBER:	BINARY NUMBER:
64	1000000
65	1000001
66	1000010
67	1000011
68	1000100
69	1000101
70	1000110
71	1000111
72	1001000
73	1001001
74	1001010
75	1001011
76	1001100
77	1001101
78	1001110
79	1001111
80	1010000
81	1010001
82	1010010
83	1010011
84	1010100
85	1010101
86	1010110
87	1010111
88	1011000
89	1011001
90	1011010
91	1011011
92	1011100
93	1011101
94	1011110
95	1011111
96	1100000
97	1100001
98	1100010
99	1100011
100	1100100
101	1100101
102	1100110
103	1100111
104	1101000
105	1101001
106	1101010
107	1101011
108	1101100
109	1101101
110	1101110
111	1101111
112	1110000
113	1110001
114	1110010
115	1110011
116	1110100
117	1110101
118	1110110
119	1110111
120	1111000
121	1111001
122	1111010
123	1111011
124	1111100
125	1111101
126	1111110
127	1111111

SHOP TALK

— CONDUCTED BY THE EDITOR

Our intention is to use readily available components in all the projects. This is easy for the simpler projects but becomes difficult when we design more complex circuits. This problem has arisen with the "AND" display for the counter module. Currently we lack a wide choice of multiplexed displays on the Australian Market but this is gradually being remedied as new lines are being imported by distributors. Our sample of the "AND 4145R" was received from the sole importers of "AND" LED displays, Stewart Electronics, 44 Stafford St., Huntingdale 3166.
Unfortunately there is no direct substitute for the AND 4145. We chose this display for its neat construction and easy readibility. Although these displays are fairly expensive, their advantage becomes apparent when connecting them to the PC board. It is extremely difficult to combine more than two 7-segment displays such as FND 500 and impossible to connect FND 357's together as the terminating pins run down the side of the units and allow insufficient room for solder lands and inter-connecting wires to be added.
The "AND 4145" is one of a range of displays made for "AND" of America by large assembly lines in Japan. They buy LINE-TIME from under-producing manufacturers and specify custom-designed components to be produced. This satisfies both parties. The manufacturer increases his line-time and can offer this time at a substantial saving. "AND" can then afford to compete on the market with first quality components. The "AND" displays are one such line. They offer extremely good clarity and evenness of segment illumination down to 10ma for the whole 28 segments. This brightness is due to multiplexing as the segments are pulsed for a very brief period of time with a high current and this produces a much higher-efficiency glow. The 10ma we are reading on the multimeter is only an RMS reading and does not take into account the pulsed contitions.

The sublimality (hidden-ness) of multiplexing the display will be revealed in our project next issue. By slowing down the scan rate with an adjustable 4553 IC, we will be able to see how the individual segments are strobed. You may use either your own home-made display or the "AND" display.

PARTS AVAILABILITY

We have really started something new with our back-up services. The fact that almost all the parts will be available through the network of Australia-Wide list of Stockists has already begun to show signs of feed-back. Eventually we will distribute complete kits of parts to each of these stockists, including the printed circuit boards, a few days before the magazine is due to appear. Unless you pester your local electronics shop, he will not be able to gauge the potential of this venture or know the quantity of kits to order.
Electronics is growing so rapidly that not only will the already established resellers be extending their range of stock, but a number of progressive operators have already considered expanding their operations. Three which come to mind are: Altronics of WA, Dick Smith (naturally) and Ellistronics.
Jacar has recently been put in the adept hands of Gary Johnson as it look like he will make the operation flourish. See their advert in this issue.

At the moment you will need to shop around as any individual firm does not, and can not, carry the full range of electronic components, kits or every piece of equipment imported into Australia. We have therefore to bring you a selected list of suppliers to cover the needs of the magazine and also the requirements of the more advanced individual experimenter. It would be appreciated if you would inform us of your local stockist if he is not already included on our list. Similarly, any supplier on our list who does not live up to expectations or caters for other electronic fields, could also be mentioned.
Since electronics is expanding at a phenominal rate, it would not be excessive to expect your local supplier to expand by 10% to 20% in the remaining part of this year. This will come about not only due to the sales generated by the magazine but by the increasing awareness of schools, students and firms. Some increase will be attributable to our new range of exciting kits and the fact that many readers have carried out my initial comments about making at least one project from each issue. Actually numerous readers have placed orders for every kit and PC board on the order form. This has highlighted the crying need for new progressive kits in the low-price bracket. In future we will be combining a number of projects and extending the basic kits to form more elaborate projects.
With this approach you will be able to construct a large model without feeling the 'bite'.

LETTERS

Mr MacGregor has sent an addition to the article in issue No 2 on REMOVING IC's. He has had experience in this field and suggests a more suitable method of removing the solder is to involve one of Newtons Laws, He writes:
"If a solder-land is heated with the soldering iron and the PC board tapped sharply on the workbench, the molten solder will keep going. Try it! After a few experimental taps, you will find Newton is correct. You will finish up with a solder-free solder land. To release any remaining grip, move the wire with a screwdriver. It will then become completely free. The IC can then be plucked from the board with your fingers.

Many thanks for this suggestion. I think it is an ideal method. I have not tried it myself as it is completely taboo when repairing large printed circuit boards under normal situations. The reason why you should not allow the unwanted solder to flick off any of the solder-lands should be quite obvious. Some of the solder may bridge a connection elsewhere on the board and produce an additional fault. This would be extremely hard to detect and just multiply your problems. However on an unwanted PC board the tapping method is ideal.

Another letter on this subject arrived from Mr Mackrill. I'm not sure whether he is taking us for a ride or not. We enjoyed his letter so much, I'll present it in full.
He writes: "I am a newcomer to electronics and have found your first two editions very enjoyable and informative. After reading the column on removing IC's, I tried the method but found it very difficult to get the Alfoil to stay put. This was my first attempt at removing an IC and I gave up in disgust. After a bit of a think, I thought of using a Utilux 25amp battery clip. After grinding the teeth off so that both the jaws were flat and parallel, found it was just the right size to go on a 14 pin IC and short out all the pins. Putting the board in a vice and applying heat to the pins with an Oxy-Acetylene torch, the IC came off the board very quickly; with the clip acting as a heatsink to the extent that the body of the IC barely had time to get warm. I have removed a Schmitt Inverter and a 4011 using this method and put them onto another board with excellent results. (They still work)
I have found this method much easier than trying to get the Alfoil to stay put. Thanks for a great magazine."

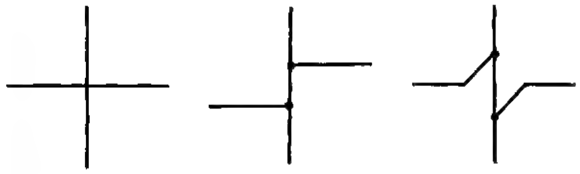
—/\/\/— or —[ ]— ?

We must be the first magazine to have a double standard. With resistors, that is. We have decided to satisfy both parties and present some our circuit diagrams using the well-known zig-zag symbol and include one circuit using the "BOX" symbol. This is introduced as a trial to gauge further reaction as the letters received to date have been quite interesting. Almost all those received were in favour of the zig-zag symbol. This may be a biased result as those preferring the new style may not be particularly vocal or literary. This is generally typical when a change is taking place or about to take place. In our case, those hobbyists being brought up on the new box symbol are young beginners, not too intent on expressing an opinion.
After ringing a number of organisations, I learned that High and Technical schools are becoming more involved in electronics and their courses specify the new box symbol.

Instructors are required to teach these new symbols and it seems their efforts are most noticeable in the younger sectors. We are seeing it too, in the circuit diagrams being sent in as project material.

One interesting point was expressed by Mr A. Macgregor. He writes: "When Mr. T. Baitch sits down and works out an electronic circuit in the rough, does he spend time drawing little boxes for resistors? Perhaps he does. Nobody else would waste this time."
A number of other letters followed along the same lines. I must be fairly impartial and consider the answer would depend on which symbol was your introduction to circuit drawing. Accordingly young hobbyists might, in fact, draw the circuit using box-type resistors.

Maybe we have accepted to dual resistor symbols, but no amount of talking or persuasion will bring us to accept the symbol for non-connected wires. We don't consider this symbol sufficiently clear. Suppose you had only one jumper in the diagram and it appeared as in the first sketch.



Would you consider that a dot was missing or the wires were jumping? Without a comparison you do not have a reference and too much importance would be placed on the inclusion or omission of the dot. These dot become extremely important and each connection has to be physically examined in the circuit diagram to determine if a connection is intended. There are two better methods of distinguishing between a connection and a non-connection. These involve staggering the wiring to produce a "Tee" intersection so that a cross-over is represented with a dot and connected wires are represented with two dots.
The only time I will accept directly crossing wires without a dot applies in matrix diagrams. With so many wires passing over each other, it would be virtually impossible to include bridges.

ORDER FORMS

The inclusion of an order form and parts list in each issue has kept our despatch section neat and efficient. It is considerably faster to process a printed order form over a hand written note as we arrange our shelves to match the printing. Some readers are still reluctant to cut out the order forms in case they lose the information on the reverse side, albeit only SHOP TALK or PUZZLE PAGE. Unless we leave the reverse side blank, I do not think we will ever be able to overcome this situation. Some readers problems are compounded as they do not have access to a photocopying machine and must resort to hand copying.
I realize this is particularly upsetting if you wish to send for the transistor offer. I have a solution.
Write your name and address on the coupon then photocopy it! You may combine both coupons onto the one photocopy.

WHICH BOX?

Last issue we presented a table showing the comparisons between three makes of project boxes. These boxes are generally fairly expensive and in some instances, exceed the cost of the electronics they house. After a little searching and help from readers, I discovered that you could provide an enclosure for a project at a considerably reduced cost. Obviously the finished product would not be as 'classy' nor as rugged but the savings may be of greater importance.
The range and availability of alternate housings falls into three categories:
1. Adaptions and modifications to household containers.
2. Purchase of suitable 'asthetic' containers intended for any use other than electronic.
3. Purchase of basic constructional materials to make a box.

If you look around your own home you will find a dozen or more suitable boxes just waiting to be filled with an electronic circuit. Look especially for cosmetic containers and presentation containers. Food containers or sewing kits or sports boxes such as fishing tackle boxes can be used.
I found three ideal boxes in our local bank; the last place you would expect to find a project box. These money boxes are supplied by the ANZ bank and consist of two similar halves, the base being a hexagon with six sloping trapezoidal sides. If you bank at the ANZ, get a couple of these boxes. They form an ideal project box and we intend to use them in the next issue for a great project. The quality of the plastic is superb and for $1.00 you get a 14-sided money box which can be split into two or clipped together for a large project. The slot in the top will accept a slide-pot or 20¢ coins and the money you save by using this project box can be banked with Mr ANZ.

Finally, the third method of obtaining a cheap project box is to buy the basic materials and hand-fabricate it yourself. One popular method was suggested by Mr J. Ritchie. His pupils purchase PVC downpipe 100mm x 50mm and cut it to length. It is amazing how many boxes can be cut from the rectangular section. The ends can be made from either pine, particle board or plastic. You can use special PVC glue to attach the ends or screw them into the PVC with small self-tapping screws. The PVC downpipe costs about $6.00 and the glue about $2.00
Don't say you can't find a project box, just use your imagination and look around your own home.

Well, once again I'm rapidly running out of room. I've got just enough space to give you the answers to the Basic Electricity Course and some corrections which have come to our notice reguarding issues 1&2.
I have had to hold over a number of projects till next issue due to the unavailability of specialized parts. I hope this situation will improve as we intend to produce projects using IC's other than run-of-the-mill types.
Maybe it will improve as Japan is coming on the market with an expanded range of even lower priced Integrated Circuits. While speaking of IC's, I would like to clarify a point contained in the Editorial of issue 2. Obviously I was referring to the 20-watt stereo chip itself for $5 and not the completed amplifier.
As from the next issue I will separate LETTERS from the general discussions in SHOP TALK and present them in the depth they deserve.

FURTHER CORRECTIONS TO ISSUE No1

Two further corrections have come to my notice.
Page 11: The 4.7mfd electrolytic in the LED Zeppelin circuit should be reversed. The positive lead connects to pins 4,8 and 9 for guaranteed starting. Strictly speaking, the electrolytic should be non-polarized as the voltage reversals are as high as the charging voltage.
David Willing, 3104, found the symbol for the CD 4001 in the LED Zeppelin circuit to be incorrect. He could not get the circuit to oscillate and substituted a CD 4011. It worked perfectly. On re-fitting the CD 4001 and turning the 4.7mfd electrolytic around the other way the circuit once again began to oscillate. Note this fact on the LED Zeppelin diagram immediately.

P 30. The MINI AMPLIFIER diagram has a wiring mistake near the 100mfd electrolytic driving the speaker. The 1k5 load resistor should terminate on the negative side of the electrolytic, next to the speaker and NOT the positive side. It is presented correctly in issue No 3, under the heading: LISTENING BUG on the TRANSISTOR PAGE.

If the LED Zeppelin does not oscillate, replace the 4.7mfd electrolytic with a low loss type.

CORRECTIONS TO ISSUE No2

P 19: WHICH BOX? The small Zippy and Jiffy box should be UB5.

Answers to BASIC ELECTRICITY

P.14. 0.005A, 2.34A, 10,000V, 3,470,000 ohms
100v, 20,000 ohms, 5.3A, 0.68A.

P.15. (a) 0.2A (b) 144v R_t = 48.5 ohms
I = 2amps I_a = 1 amp I_b = 8.75amp
V = 4volt

P.17. (a) R=1k1,)b) R=6k6 (c) 1,175 ohms
(d) 6k6
R = 9k9 R = 2,350 ohms R = 2k2
R = 1,320 ohms R = 2,480 ohms
R = 1,498 ohms R = 767 ohms.

TV Servicing Part II

by our staff serviceman

Our previous article on TV servicing outlined fault-finding dry joints. This month we continue along the same lines, with the next stage in simple repairs.

As with every type of profession, a great deal of skill is needed to solve even a seemingly simple task. As I gradually phase out of TV servicing, I wish to pass on my accumulated skills to the next generation of servicemen. This article is not designed to put already established servicemen out of business, nor will it be sufficiently comprehensive enough for you to go off boldly and start repairing TV's. What it will provide is, a collection of readily available facts as a back-up for that time when you get landed with a problem set.

Many colour TV faults present themselves time and time again. A particular fault will show itself in the whole batch or series of sets. This means each brand has its own list of special faults. Generally a serviceman can predict a fault before he takes the back off the set. Obviously this means he has tackled the fault previously. But how does he handle the situation on his initial attempt? Only time will tell. He must use his collection of skills to their fullest and gradually eliminate each component, one at a time.

Climb aboard and come with me on a few of the jobs carried out last month. See my reasoning and approach to the problems. This will not be an "in-depth" coverage, just a collection of related faults. This list could go on indefinitely, so let's pick out just a few.

IT's JUST A FUSE!

How often have I heard the customer say "It's just a fuse! Bill, down the road, had the same fault and his set just needed a fuse."

Well, maybe it does just need a fuse. But nine times out of ten the set will contain a fault which caused the set to fail. You see, to an experienced technician a fuse can fail in three ways. Let me list them:

1. The first case is fairly uncommon,but it does happen. The fuse wire inside the glass tube will fracture at one end, inside the end-caps. The fuse will still look to be perfect since the break is hidden, but a multimeter will show it to be an open circuit.

2. The second case occurs through general fatigue. The fuse wire gradually oxidises over a period of years and finally fails for no apparent reason. This over-stressing occurs when the set is turned on. The current rushing into the power supply can be in the order of 10 amps or so for the first few cycles. You will be able to see the fuse stretch and sag as it absorbs this high current. Obviously it will not take this treatment for ever, and finally it fails. One way of overcoming this problem is to fit a DELAY fuse. It consists of two pieces of wire with slightly higher current rating, soldered in the middle with a dob of solder. This type of fuse will still weather slight surges yet fail at the specified current flow by melting the solder.

There is another style of delay fuse which deserves a mention. It consists of a coil of wire similar to the filament of a lamp. It has a special style of failure all of its own. The added heating-effect of this coil can cause to wire to burn through after many hundreds of stressing, even through normal use. The break is very hard to see with your eyes and you can quite ofen be trapped. Always test fuses with a multimeter set to low ohms range.

3. The third case is quite obvious. It's the case where the fuse has exploded with such violence that the glass tube has shattered into little pieces all over this inside of the set. The only parts left are the two end caps, firmly welded to the fuse clips! You couldn't mistake that a dead short has taken place!

From these three tell-tale signs, you will be able to interpret which parts of the power supply will also need replacing.

In the first two cases I would suggest testing the four bridge-rectifier diodes before replacing the fuse, to confirm if they are ok. In the third case, I definitely suggest testing the four diodes. To test them for complete shorts, you will need to lift one end of two diodes from the board and check each diode individually with a multimeter set to high ohms range. The capacitors across each diode should also be checked, especially in Luxor sets. The posistor driving the degaussing coil can also cause the fuse to blow. See it explained later. Quite often you will find only one or two diodes have been affected. It will depend on the severity of the spike entering the supply. Replace the damaged diodes with 600 volt types, having a current rating of 3 amp.

I suppose you are wondering where a high voltage spike could come from? Would you believe it comes from a flash-over at the point where the EHT lead enters the picture tube. The high voltage appearing at the instant of turn-on sees the picture tube as an uncharged capacitor. This EHT is capable of jumping at least 7cm across the outside of the tube and piercing the relatively thin insulation on the degaussing coils, placed around the tube. Any small amount of dirt or cigarette tar-tar will increase the spark ten-fold.

This is especially dangerous on cold, damp days when the corona discharge appears as fine lightning flashes from the EHT button. The possibility of flas-over is most acute under these conditions. The pulse travels through the degaussing coil to the input of the power supply and appears as a powerful high-voltage spike. This is capable of puncturing the power supply diodes quite easily. It is the voltage which destroys the diodes, not the current.

SILICONE SEALANT

With every colour repair, one of the first preventative measures is to seal the EHT cap. Before removing the EHT lead, you must make sure the set has been off for a minute or so. The most satisfactory method of discharging the picture tube is with the earthing spade provided, or with two long-handled screwdriver in contact with the earthing strap on the back of the tube. It is important to avoid a large spark or zap as you could create enough flash-over to destroy the transistors in the tuner or the power supply. To reduce this spark, the tripler lead (which contains the corona cap) can be unplugged and touched on the back of the tube, then taken back to the input hole. This will recharge the capacitor in the tripler ready for the second recharging. This should be repeated a number of times until the spark becomes small. The tube can then be fully discharged with a jumper lead clipped to the earthing strap on the back of the tube. Clean around the hole with a dry rag and apply Selleys silicone sealant to the button and the circular sealing rim of the corona cap. Fit the cap onto the tube and smooth off with your finger. At the same time build up the insulating layer around the cap. Blaupunkt and Nordemende sets are specially prone to damaging the power supply after a flash-over.

REPLACING THE FUSE

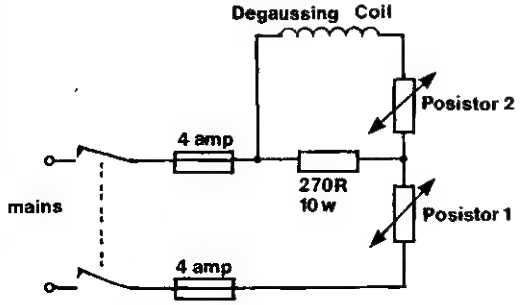
It may now seem a simple matter replacing the fuse with anything of a higher rating. But you will be wrong. A great deal of thought has gone into which type of fuse is needed for a particular set. Four different types of fuses are used according to the stress placed on them when the set is turned on. Transformerless sets such as Blaupunkt demand the heaviest surge currents as they do not have a mains transformer to buffer the input current. For this reason they need 3.15 amp or 4 amp fuses. Nordemende, with the same arrangement, specifies 5amp. Japanese sets with mains transformers use 2 amp fuses. It is important to replace the fuse with one of the correct rating as it performs a demanding role and must be ready to act when an overload occurs yet not burn out un-necessarily.

DEGAUSSING

I mentioned the degaussing coil. What does this coil do? Possibly you are aware of the shaddow mask, located about a couple of cm behind the picture tube screen. This mask consists of up to 500,000 fine holes through which each of the three electron beams pass. The operation of the shaddow mask can be likened to this situation:
Three metres from a sliding door, position three people in a row, and three symmetrically on the other side of the door. Close the door, making a 30cm slit. You will find that each person will be able to see only one opposing person through the slit. This equates to the three guns, the hole in the shaddow mask and the three dots of phosphorus on the inside of the picture tube.
Since electrons are highly susceptable to magnetic and electrostatic influences, the slightest magnetic retention in the mask will deflect the electron beam a fraction of a millimetre and it will hit the next-door phosphor dot. This will be a dot of incorrect colour as each of the three dots form a triangle called a triad. The most critical colour change is with the red beam. If this beam is deflected ever-so-slightly, the red portion of the picture tends to show as pink or yellow. This is most noticeable on faces. As the actors move across the screen, their faces change colour! This fault is a gradually worsening symptom which is created by one of three factors:
1. Shifting of the shaddow mask. This shaddow mask is sprung on a heavy frame within the tube to allow for thermal expansion and contraction. If the set is dropped or bumped, it may come out of alignment.
2. External magnetic influences such as large speakers, or children with magnets, can create large magnetic spots on the screen.
3. Failure of the de-gaussing coil and its associated turn-on components.

HOW THE DEGAUSSING COIL WORKS

Every TV takes a fraction of a second for the picture to appear. In this blank time, the coil of wire around the periemter of the back of the tube is subjected to a very high current. This fades to zero in the space of ½sec. Its effect on the mask is to stir up the magnetic particles and orientate them in a completely random pattern. As the magnetic flux reduces, the residual magnetism in the mask becomes zero. This occurs every time the TV is turned on from cold. It is achieved by two positive-temperature-coefficient thermistors, contained in a three-leaded package. On turn-on, these thermistors are very low resistance, and most of the current flows through the de-gaussing coil.
This heavy current heats them up rapidly and causes their resistance to rise. This causes the current in the coil to reduce to near zero. It is kept near zero during the operation of the set by the 270ohm bleed resistor keeping the posistor slightly warm. Posistor #2 is situated next to posistor #1 and effectively keeps to degaussing coil turned off.
Normally you would never see the effectiveness of the de-gaussing system, but it can be viewed by setting up this experiment:
Remove the de-gaussing coil plug and re-connect it via a



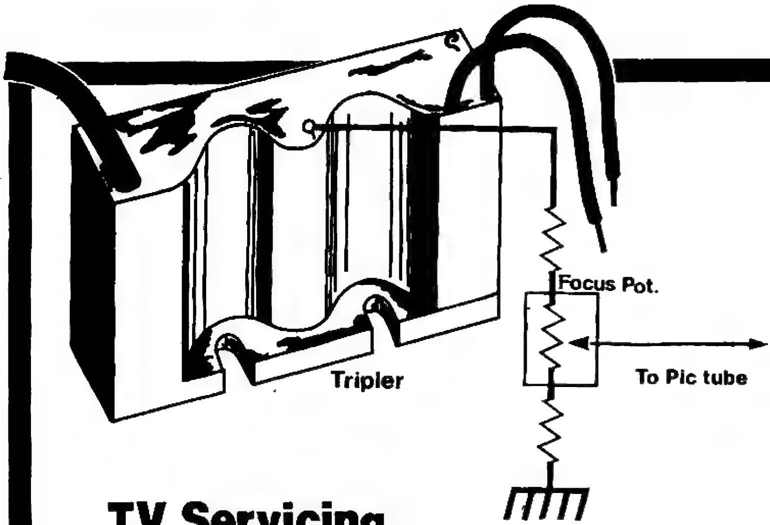
Degaussing-Coil Circuit

switch. Turn on the cold TV and close the switch while watching a test pattern. You will see the screen break into pretty patterns, similar to oil colours on water and any little tinges of pink or red will disappear. If nothing occurs you should suspect the posistor.
Because the posistor has an extremely small cold resistance, it is possible for it to blow the mains fuse. If you suspect this to be the case, remove the posistor for a week or so and run the TV set. It can be omitted without any detrimental effect.

THE TUBE

Second-hand colour TV's are coming on the market in ever increasing numbers as the more affluent of us realize the necessity to up-date. Two factors have influenced this increase. Firstly: Many people who took out a rent-purchase or rental agreement are now in their fourth year of renting. They are tending to abandon the agreement in preference to owning their own new, up-to-date set.
Secondly: The majority of four-year-old sets are on their last legs and after two or three service calls, are tending to be left aside in an un-repaired condition for a new portable set.
One of the disturbing factors with colour television has been the ignorance of picture tube life. Most of the public, including the slick salesmen, considered a colour TV tube would have an exceptional life. They took their reasoning from quite irrelevant data, such as the life of their Stromberg-Carlson or STC black and white TV. They reasoned the life of their "good old set" was about 20 to 25 years and the picture was quite watcheable, so surely with improved technology, the life on any colour TV would be about 15 years! They knew nothing about the workings of a colour tube, the degree of drive needed to produce a watcheable colour picture or the quality of the tube. They just speculated on 10 to 15 years. Unfortunately there was no technical back-up from the manufacturers to enlighten them on this matter, nor has there been ever since! If the truth were known, many people would have considered a purely rental agreement.
What is the reason for this failure rate?
After a few years of average use, the quality of some colour picture tubes reduces to absolutely unwatcheable, while others remain almost perfect.
This is due to a combination of many factors. The tube itself, the degree of drive, the method of driving the tube, the number of hours the TV is viewed each day and any prolonged periods of non-use.
All these factors put together enable me to state two indisputable facts.
Almost all 43cm tubes are 100% reliable. (excepting Sony).
After 4 years, 63cm tubes will fall into two groups: very poor condition and nearly perfect condition.

Once a tube begins its down-hill decline, there is very little we can do. A rejuvenation may last up to six months or as little as one day. Two methods of improving the picture are available. They are only a 'stop-gap' measure and cannot be guaranteed. The first method requires a REJUVENATOR. These are extremely expensive and range in price from $295 to $485. You would need to 'hit' a lot of tubes to get your money back. It is quite easy to make your own unit for $40 to $60 and this will be detailed in a later issue if the demand is sufficiently large. It will be only a single meter type with switched inputs to read each gun in turn. Rejuvenators are of dubious value. They really have very little use and in fact I have found there is no connection between the quality of the picture and the reading on the machine. In fact the reading are quite unrelated. A tube may show only 2% emission and yet give a fairly good picture, while a poor picture has recorded a 28% reading!
Rejuvenators work in two different modes. Some rejuvenate the tube while the filament is still on, others turn the filament off before supplying a high voltage between cathode and first accelerating anode. By far the most effective time to electronically clean the cathode is when the filament is dying down. Otherwise the added heat produced by the blasting process, when added to the filament temperature, will tend to overheat the cathode, This will cause the whole gun assembly to expand and reduce the effectiveness of the blasting process. The time taken for rejuvenation will thus be increased and the cathodes electron emitting properties will



TV Servicing

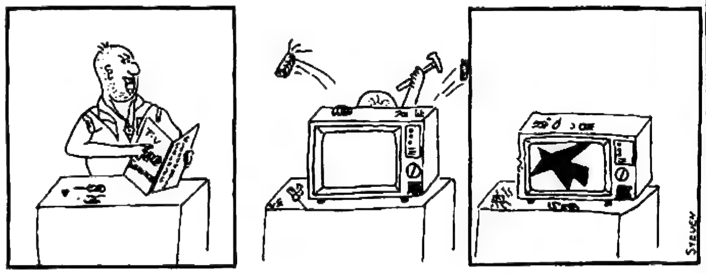
be reduced dramatically. Once you have a basic rejuvenator in your possession (try to borrow it) you will need to buy a set of picture tube adaptor leads from Swe-Check. There are about 7 popular leads and at $13 each, they are cheaper than trying to assemble your own, as some of the plugs and sockets have had to be specially manufactured.
The second method of brightening up a picture is to use a PICTURE TUBE BRIGHTENER. Since the picture brightness is heavily dependent upon the ability of the three cathodes to emit electrons, it follows that an increase in cathode temperature will greatly increase this flow and brighten the screen. Normally the tube operates on 6.3vAC. We can increase this voltage by up to 4v with a reasonable degree of safety. Colour TV's derive the 6.3v from one of two sources. Either a special tapping on the power transformer, or a winding around the core of the EHT transformer.
If your set is the former case, you will need a small transformer such as #169 from Swe-Check. It is a flying-leaded auto-transformer which can be fitted to almost any set. The instruction come with the unit. As an alternative, I fit a complete power transformer type 2155. It has voltage tappings from 6v to 15v and is wired back to the mains switch. If the set suffers from an open filament, this transformer can be used. Firstly you will need to heal the filament by tapping on the neck of the tube. If it begins to glow, you can be assured it will stay alight. The only danger is turning off the set. Most of the damage with colour picture tubes occurs not during the operating time but during the period when it is not used. This is the reason why families with large TV appetities find their set lasting a long time. If the filament were to be kept alight all the time, it would not suffer from open cathodes and open filaments. It is the heating up and cooling down which stresses the spot welding in the gun to create intermittents. By wiring the transformer back to the incomming power lead, we can arrange the filament to be on 24 hours a day. That is, providing the customer does not turn off the power at the power point!

If the filament voltage is derived from a winding around the core of the EHT transformeras with Philips and HMV sets, it is a simple matter to remove this winding and replace it with one having a few more turns. I generally rewind the winding with ordinard hook-up flex and add 3 more turns. The ends are taken directly to the tube. It does not matter in which direction the winding is wound. A small wire-wound resistor of about 2.2 ohms (2R2) is included in one lead to prevent the picture tube burning out on turn-on. Watch the glow of the filament and compare it with the original glow. Reduce the number of turns to compromise between picture quality and excessive glow. If the filament is too bright, the remaining life of the tube will be used up in a matter of weeks.

FOCUS VOLTAGE

Once the tube has been brightened up you will need to adjust the focus. This voltage is generally picked off the tripler as the first rectified voltage. It emerges at approximately 6 to 8KV DC and a voltage divider network is provided by the focus pot in conjunction with upper and lower limiter resistors. Most tubes require a potential of about 4.5kV for sharp focussing. When adjusting the focus control we keep the picture at full scan and look at the centre of the picture. Rotate the focus control to either side of the optimum point to make sure it is in the centre of its range. If it is completely one-ended, follow these steps: It is difficult to measure the voltages in this stage as they are above the maximum range of most meters. To extend the range of say a 30k/volt meter, you will need to add a 4M7 resistor to the positive probe. This will not give you an accurate voltage reading but rather a comparison between each circuit point. You will not need to actually touch the high voltage points with the resistor as it will readily receive spray as the DC voltage has a high-frequency component. The length of the corona discharge will be a sufficint comparison. The low side of the focus pot should be about 3kV and the high side about 5kV.

The most common fault involves the upper resistor burning out. Well not actually burning out, that's just a figure of speech. It tends to 'track' and go high. This is due to the high voltage appearing across it. An open focus resistor will not only give poor focus, it will cause the picture to become very dark, or even totally black.
We call the focus circuit a high impedance circuit, meaning the resistors are in the order of meg ohms. This means the current flowing through them will be only milliamps. Any loading on the circuit such as leakage or a multimeter, will reduce the voltage appreciably. Three brands of sets have a fault which does just that. They have a 5kV spark-gap across the feeder line to the focus anode. If this gap becomes dirty, it will reduce the focus voltage very slightly and create an intermittent focus fault. Sets prone to this fault are: AWA, Luxor and Nordemende. All that needs to be done is clean the spark gap. If corona has damaged the insulation, it will need to be replaced. Don't leave it out.

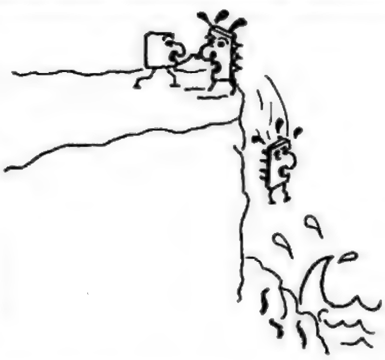


While we are on the subject of triplers, corona and silicone sealant, I would like to add the three go well together whenever a hissing sound is heard or corona discharge is seen from any high voltage point. Corona concentrates on projections, in other words, the discharge into the air is enhansed by the slightest spike of soldering or piece of wire protruding from a connection. Always cover these bare joints with silicone sealant - it may save you the cost of an expensive component in the long run. I have replaced a number of triplers and focus pots merely through corona discharge causing tracking right down the component to earth. The passage is aided by dirt, fluff and cigarette tar to the extent where up to a 5cm track was formed...damaging the component completely. A stich in time......

A number of other rather simple faults involved my skill, in-between these faults. Their solution was simple but they proved a challenge at the time. Five of them were dry joints; one in the edge connector socket, one being a capacitor lead, one turned out to be a faulty push switch, one a faulty fuse and the most recent turned out to be the moulded power plug. These are items you do not readily expect and pin-pointing them can take extra time. Take the three cases where the customer worsened the fault by taking the back off the set and "trying his hand." Two even tried to re-converge a perfectly converged picture! ...with disasterous consequences. To re-converge the picture can take an inordinate length of time, and becomes an almost impossible task, especially when the customer has turned every knob with in his reach.

So, all in all I had a fairly busy, active month. I have a number of interesting points to bring up on the more complex jobs. These will be discussed in the next article.

THE TRANSISTOR PAGE

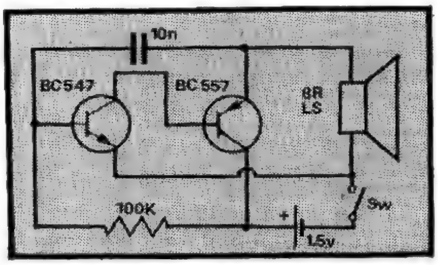


Use Your 2 FREE Transistors in These 3 Simple Projects

(1) MULTI-PURPOSE OSCILLATOR

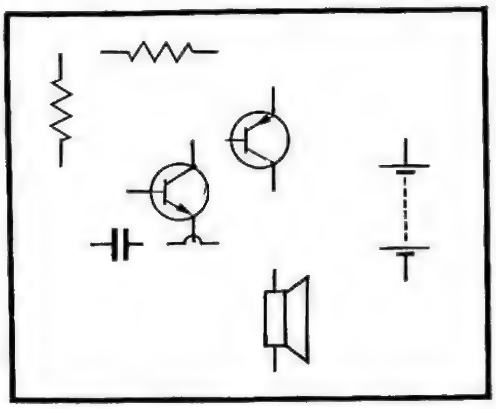
by G. Khalil. 2148.

This multi-purpose oscillator is a two-transistor directly-coupled amplifier with very high gain. The output is coupled back to the input via the 0.01mfd capacitor to give positive feedback. The frequency of oscillation is set by the 100k resistor and the 0.01mfd capacitor. It can be used in a number of handy applications including a morse-code practice set, electronic door-bell buzzer, or as an audio signal for testing amplifier circuits.
By changing the value of the 0.01mfd capacitor we can alter the frequency to any desired sound or pitch. The circuit will operate from a wide range of voltages (1.5v to 9v) with a corresponding change in frequency and volume....about 3v or 4.5v will be the most suitable voltage.

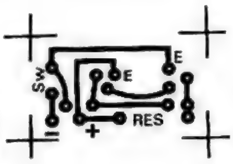


OSCILLATOR

This circuit is actually a re-arrangement of the TICKING BOMB project in issue No1. The only two components which have been altered are the 2.2mfd electrolytic and 100mfd electrolytic across the battery. Your first task is to re-draw the circuit according to our standard convention so that the layout becomes more self-evident. To help you, the individual components have been drawn in their correct positions. You will need to add the connecting wires to complete the circuit. Check your drawing accuracy by comparing it with the circuit on P29 of issue number one.



Finish This



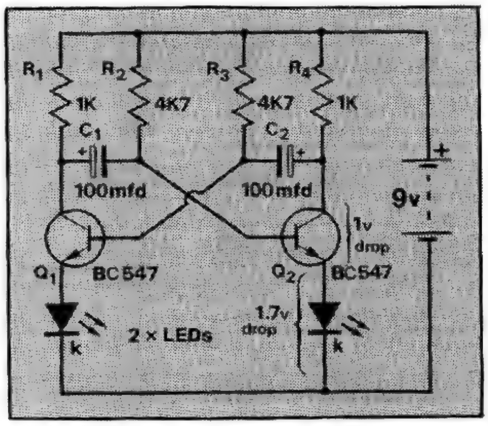
Oscillator P.C. Board

A small printed circuit board has been included which is simple enough for you to make by hand. You will need to cut a piece of copper-clad board and clean the surface with a powder cleaner. Trace out the circuit with a black-lead pencil. Fill in the areas to be protected with a spirit pen such as Dalo or Edding 3000 or you can use nail polish or nail lacquer, in fact anything which is not water soluable and which will resist the ferric chloride etchant. Refer to the article on making your own printed circuit boards for the etching times and precautions. Drill all the holes with a 1mm drill. Insert the parts as shown in the layout diagram and connect the battery, speaker and switch. It's so simple its almost guaranteed to work. Experiment with changing the frequency by placing your fingers across the capacitor and resistor. You may substitute either component to obtain any desired frequency.

• •

(2) LED FLASHER

The LED FLASHER circuit is a square-wave or multivibrator circuit driving 2 LEDs. Since both halves (or sides) of the circuit use equal-value components, the 'on-off' ratio for each LED will be the same. This type of circuit is guaranteed to start and flash with almost any transistors and any value of resistors and capacitors. The way in which it operates is quite interesting.



Led Flasher Circuit

HOW A MULTIVIBRATOR WORKS

the battery is connected, both capacitor begin to charge up. The charging path for C_1 is: R_1, the base-emitter junction of Q_2 and the second LED. The equivalent components charge C_2. This action puts a forward-bias on both transistors and they both immediately try to turn on. Fortunately, due to component tolerances and transistor switching times, only one of the transistors will win. Suppose transistor Q_1 wins. This action will effectively bring the 100mfd electrolytic C_1 down towards the negative rail, in fact, about 2.7v above the negative rail (made up of 1.7v drop across the LED and 1v drop across the transistor as shown in the circuit diagram). Now C_1 will have charged up slightly during the initial turn-on period and say it has charged to 3v. This will be just like placing a 3v battery from collector of Q_1 to the base of Q_2. The base of Q_2 will see a resultant voltage of 2.7v minus 3v or -.3v This will turn the transistor "hard-off". C_1 will now begin to lose its charge via R_2, Q_1

and the first LED until the forward bias provided by R_2 begins to turn transistor Q_2 on. This tends to bring down C_2 and in doing so, turns off Q_1 and raises the voltage on the positive end of C_1. This change-over action occurs very rapidly and it is basically the 'discharge-time' which determines the duty-cycle or frequency of oscillation.
If you can visualise two points, you will begin to understand the operation of a multivibrator.
Firstly consider the electrolytics as miniature re-chargeable batteries and secondly; mentally position them alternately above and then below the transistor. This way you will be able to see how they are affecting the opposite transistor.

CONSTRUCTION

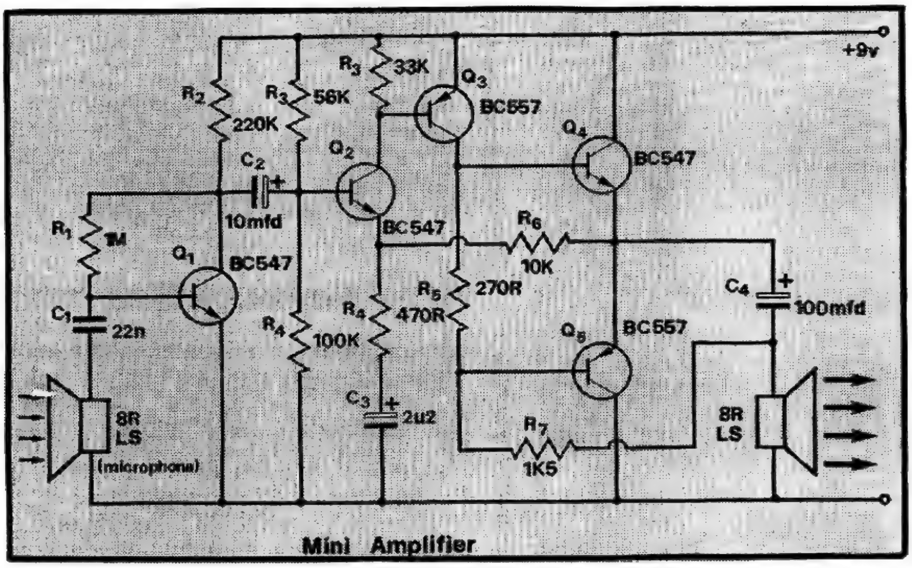
This circuit can be built on a piece of veroboard and since it doesn't have an on-off switch you will be able to solder it directly to an old 6v lantern battery. It takes very little current and will keep flashing for many days before the battery finally becomes exhausted.

• • • • • • • • • • • • • • •

③ LISTENING BUG

A. Hellier, 2281.

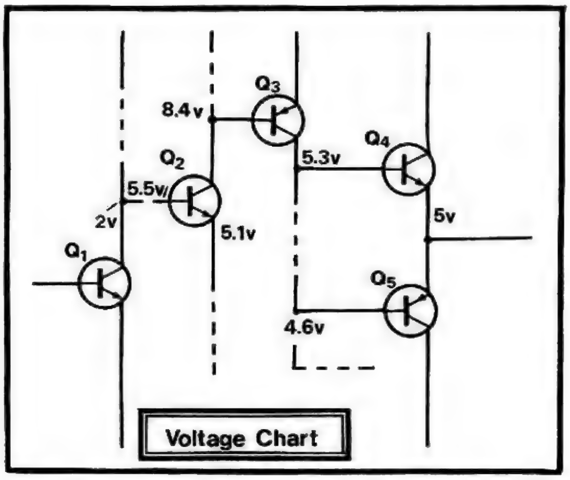
This project is an extension of the MINI AMPLIFIER described in issue number one. We have added a pre-amplifier to the front end to increase the extremely low output (50mv) of a moving-coil microphone to about 2v p-p to drive the amplifier fully. The moving coil microphone is actually a loudspeaker and can be used quite successfully if a small crystal microphone is not available. By using two small speakers in this project it would be quite easy for you to add a reversing switch and make your own intercom. We haven't gone that far and are just using it as a single direction LISTENING BUG. By placing one microphone on a long length of speaker cable, you will be able to position the amplifier quite a distance from the noise source and be able to hear the conversation. It's ideal for parents catching up with all-night talkers who should be sleeping, or conversations during quiet study times. It may even be useful for detecting the first waking cries of a young baby!



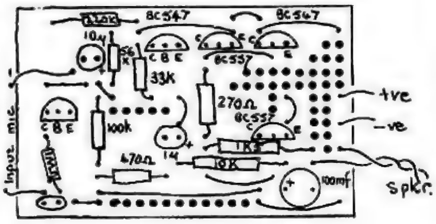
Mini Amplifier

TROUBLESHOOTING THE LISTENING BUG

The circuit can be considered as two separate stages.
The pre-amp Q_1 as one stage and the remaining four-transistor direct-coupled push-pull amplifier as the other stage.
The first transistor is in an automatic self-biasing arrangement, in which the base voltage is derived from the collector voltage. This merely saves one resistor as compared with a bridge network. The transistor will operate with any voltage over about 2v on its collector. The other point to note is the base will need to have a small voltage on it to turn the transistor on. The 10mfd electrolytic blocks the DC voltage from the remaining section so that Q_1 can be considered as a completely separate circuit, DC wise.
The remaining four transistors operate as a complete unit since they are directly coupled to each other. So if the amplifier fails to function, where do you start?
The amplifier biasing commences with the 56k and 100k bridge resistors. They provide a base-bias of 5.5v for Q_2, the voltage comparitor transistor. The emitter voltage should be about 5.1v so that Q_2 is slightly turned on. This will make Q_2 draw current and produce a voltage drop across R_3, the 33k resistor. This voltage drop is the forward bias needed to turn Q_3 on. The load for Q_3 is provided by the 270 ohm and 1k5 resistors and these terminate at ground via the 8 ohm speaker. The 270 ohm resistor is designed to give the output transistors a slight forward voltage between the base and emitter leads to prevent 'cross-over' distortion. This distortion is reduced when the base-emitter voltage is nearing turn-on and the driver transistor doesn't have any wasted swing, turning on the output pair.
The common emitter junction of the two transistors should be about half the supply voltage as both transistors are turned off during the quiescent condition. Most of the amplification is performed by Q_1 and Q_3. The output transistors merely serve to take the delicate high-amplitude signal from Q_3 and take it in turns to "pump" it into the speaker via the 100 mfd electrolytic.



Voltage Chart



Listening Bug Layout

This is a suggested layout for the 5-Transistor amplifier LISTENING BUG. It can be built very neatly on a piece of VEROBOARD which is supplied 15 holes wide and has a cut down the centre of the strip. With careful laying out you will not have to cut any of the copper tracks. Hopefully, when you first build the bug, it will not work. Then you'll be able to de-bug it. A voltage chart and trouble-shooting section will help you diagnose the fault.

• • • • • • • • • • • • • • •

Next issue we will have three more projects for your PNP/NPN transistors.

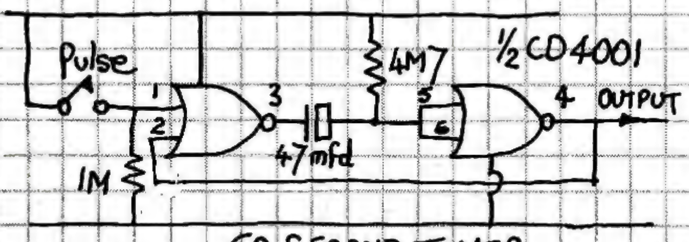
10-MINUTE DIGITAL COURSE

23 THE FULLY CHARGED CAPACITOR NOW ADDS ITS VOLTAGE TO THE OUTPUT GATE VOLTAGE AND WOULD EFFECTIVELY SUPPLY 18V TO PIN 2 IF IT WERE NOT FOR ANOTHER INPUT PROTECTION DIODE DIS-ALLOWING THE GATE VOLTAGE TO RISE ABOVE RAIL VOLTAGE. THIS MEANS THAT AT THE MOMENT OF SWITCHING, THE CHARGE FROM THE CAPACITOR IS REMOVED VIA DIODE D_1 SO IN EFFECT PIN 2 NEVER RISES ABOVE SUPPLY RAIL VOLTAGE. WITH THE CAPACITOR FULLY DISCHARGED, IT BEGINS TO RECHARGE AGAIN VIA R_1 AND THE HIGH ON PIN 4. THE SWITCHING SEQUENCE REPEATS ITSELF TO PRODUCE A SQUARE WAVE OUTPUT PROVIDED PIN 1 IS KEPT IN A LOW STATE. IMMEDIATELY THE PULSE BUTTON IS RELEASED, PIN 1 GOES HIGH AND THE MULTIVIBRATOR WILL CEASE WITH C_1 CHARGED.

THIS CIRCUIT IS EXTREMELY ECONOMICAL ON PARTS. IT REQUIRES JUST 2 EXTERNAL COMPONENTS TO PRODUCE A GOOD SQUARE WAVE WITH A FREQUENCY WHICH CAN BE VARIED FROM 1 CYCLE PER SECOND (1 Hz) TO ABOUT 30MHz, MERELY BY CHOOSING A SUITABLE RESISTOR AND CAPACITOR.

TIMERS:

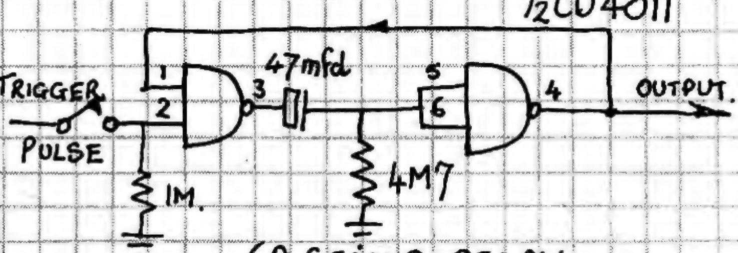
FOR FREQUENCIES BELOW 1 CYCLE PER SECOND (1 Hz) WE CAN USE EITHER OF THE CIRCUITS BELOW. A CD4001 OR CD4011 CAN BE USED AS A TIMER FOR DELAYS FROM 1 SECOND TO OVER 300 SECONDS. THE CIRCUIT WILL NOT "CLOCK". IT MUST BE RESET MANUALLY. FOR THIS REASON THE SWITCH SHOULD BE A MOMENTARY-CONTACT TYPE.



60 SECOND TIMER.

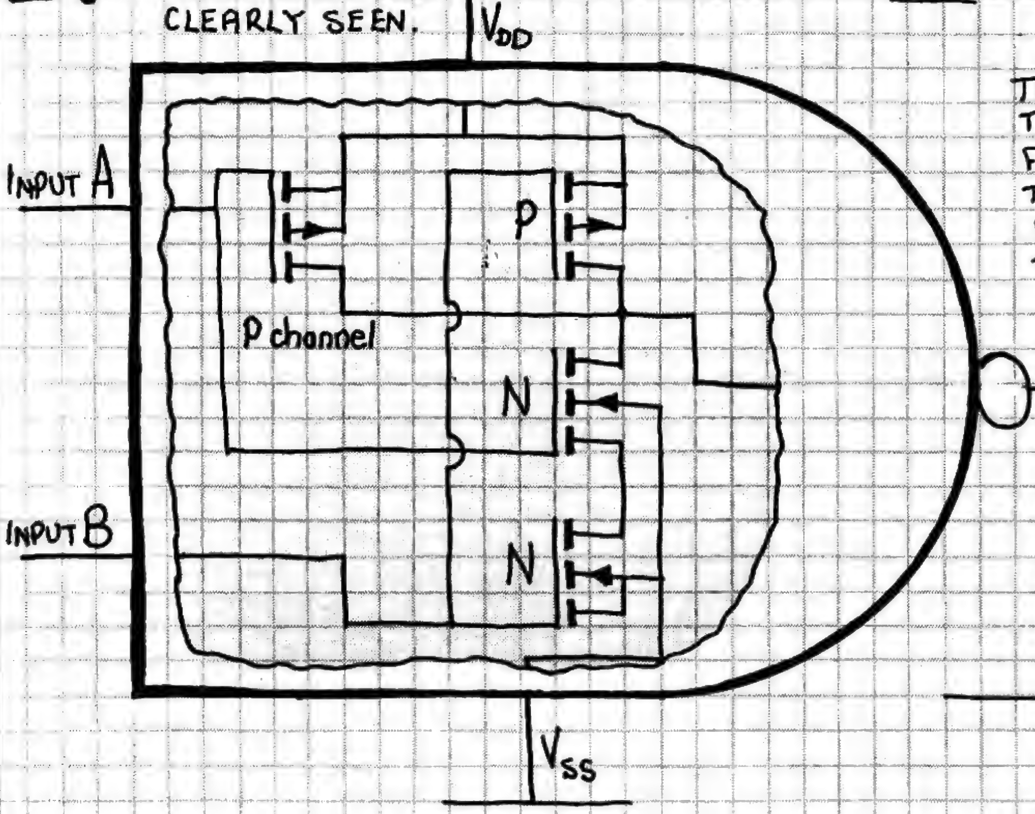
CLOSING THE PULSE SWITCH WILL START THE TIME DELAY. INITIALLY BOTH INPUT PINS 1&2 ARE LOW MAKING THE OUTPUT HIGH. THIS MEANS THE CAPACITOR IS IN AN UNCHARGED CONDITION AND PINS 5&6 ARE HIGH. THIS IN TURN CREATES A LOW ON OUTPUT PIN 4. THIS IS DIRECTLY COUPLED TO PIN 2 WHICH TAKES OVER FROM PIN 1 TO LATCH THE FIRST NOR GATE. THE CAPACITOR GRADUALLY CHARGES VIA THE 4M7 RESISTOR AND THE VOLTAGE ON PINS 5&6 RISES EXPONENTIALLY TO THE TRANSFER VOLTAGE WHEN OUTPUT PIN 4 CHANGES TO A LOW. PIN 3 GOES HIGH AND THE CAPACITOR IS IMMEDIATELY DISCHARGED VIA THE INPUT PROTECTION DIODES WITHIN THE IC. THE CIRCUIT WILL REMAIN IN THIS CONDITION UNTIL PIN 1 RECEIVES A TRIGGER PULSE.

WHEN THE POWER IS CONNECTED A LOW IS PRESENT ON PIN 2. FROM THE TRUTH TABLE WE SEE THE OUTPUT MUST BE HIGH. THE UNCHARGED CAPACITOR MAKES PINS 5&6 HIGH SO THAT THE OUTPUT PIN 4 WILL BE LOW. THIS IS DIRECTLY COUPLED TO PIN 1 OF THE FIRST NAND GATE. THE CAPACITOR GRADUALLY CHARGES VIA THE 4M7 RESISTOR AND AFTER ABOUT A 60 SECOND DELAY, THE RISE ON PINS 5&6 CAUSE THE OUTPUT TO GO LOW. IT REMAINS IN THIS CONDITION.



60 SECOND DELAY

24 IN THE FOLLOWING DIAGRAM I HAVE REMOVED THE INPUT PROTECTIVE DIODES AND RESISTOR TO ENABLE THE ACTION OF A NAND GATE TO BE MORE CLEARLY SEEN.

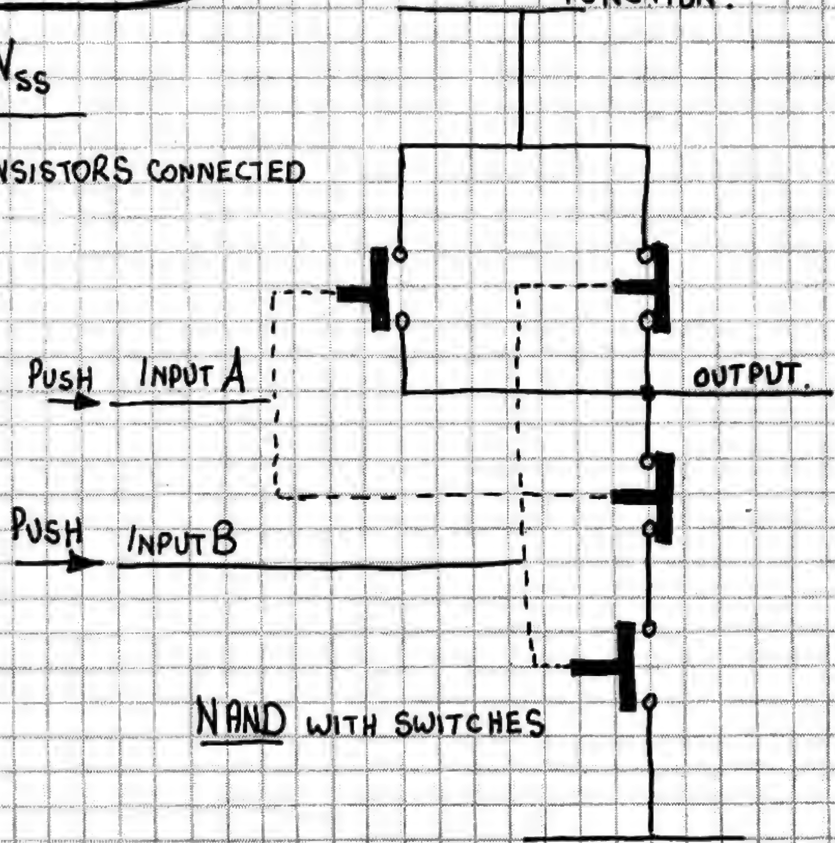


THE "GATE" OF EACH TRANSISTOR IS INSULATED FROM THE REST OF THE TRANSISTOR BY A THIN FILM OF SILICON OXIDE. THUS THE INPUT IMPEDANCE IS EXTREMELY HIGH.

VIRTUALLY NO CURRENT IS REQUIRED TO TURN THE TRANSISTOR ON OR OFF. EACH GATE REQUIRES LESS THAN 1 MICROAMP TO FUNCTION.

P CHANNEL & N CHANNEL TRANSISTORS CONNECTED TO FORM A NAND GATE.

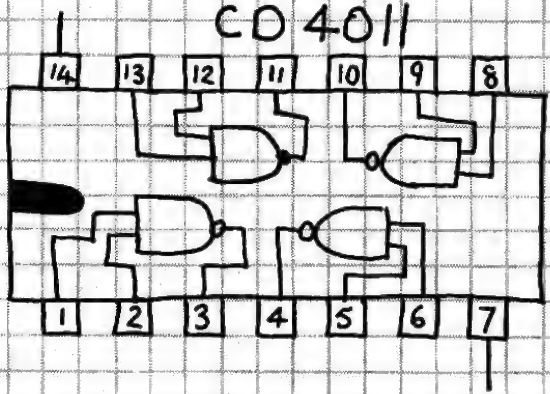
THE NAND GATE CAN BE REPRESENTED BY 4 SWITCHES BOTH INPUT A AND INPUT B HAVE ONE NORMALLY OPEN AND ONE NORMALLY CLOSED SWITCH, TO ACHIEVE THIS ACTION. PRESSING INPUTS A AND/OR B WILL HAVE THE SAME EFFECT ON THE OUTPUT AS THE ELECTRONIC NAND GATE

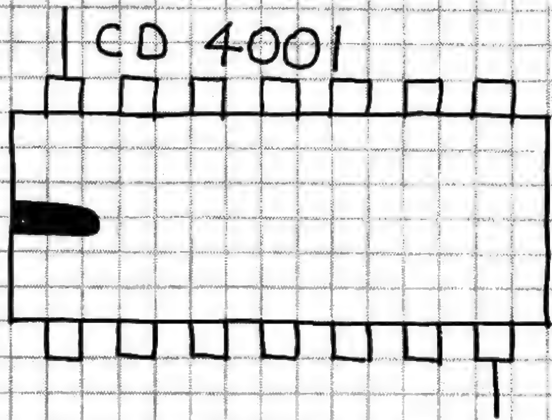


NAND WITH SWITCHES

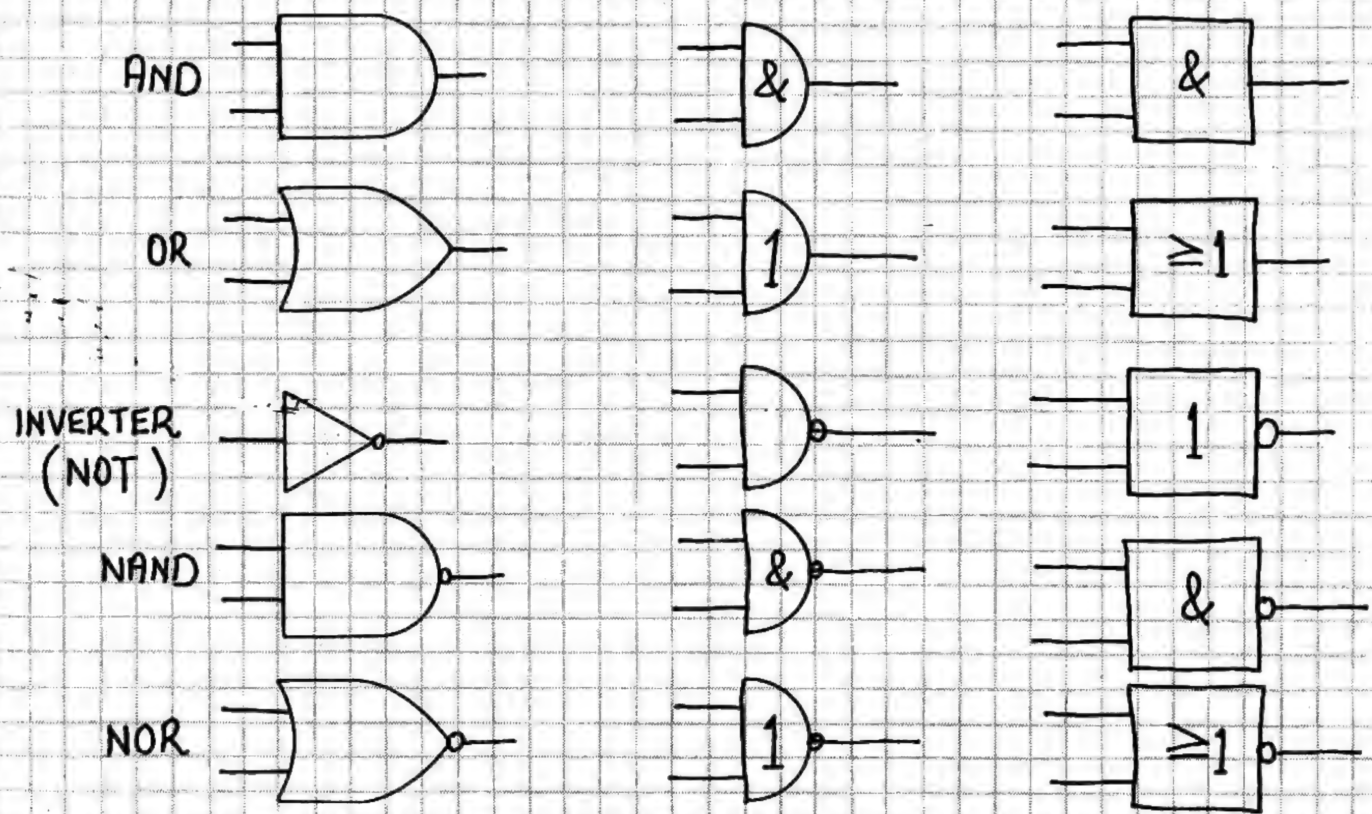
25 IN THIS DIAGRAM, THE NAND GATE IS SEEN INSIDE A CD 4011 INTEGRATED CIRCUIT. THE IC HAS 4 NAND GATES ARRANGED AS SHOWN. THIS ARRANGEMENT SUITS THE CHIP MANUFACTURING PROCESS AND ESPECIALLY THE TERMINATING PINS WHICH MUST NOT COME IN CONTACT WITH EACH OTHER. THE NUMBER OF NAND GATES IS LIMITED ONLY BY THE 14 PINS ON THE IC AND NOT THE SPACE INSIDE THE IC.

A SIMILAR ARRANGEMENT IS HOUSED INSIDE A CD 4001, WHICH YOU WILL FILL IN HERE:





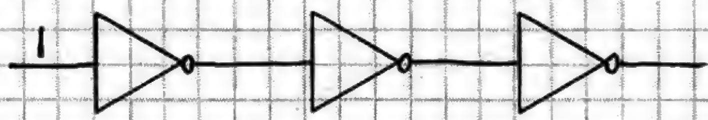
I HAVE USE THE USA-STYLE SYMBOLS FOR THE LOGIC GATES HOWEVER TWO OTHER CONVENTIONS SHOULD BE NOTED IF YOU WISH TO CROSS-REFERENCE WITH DIFFERENT MAGAZINES.



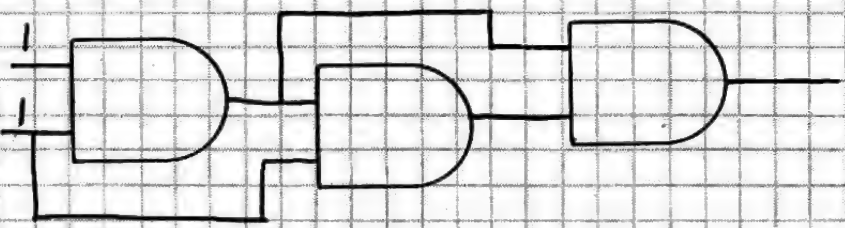
26 GATE QUIZ

USING BLOCKS 8, 9, 10, 14 & 15, TEST YOUR ABILITY TO TRACE OUT GATE CIRCUITS. THE HIGH OR LOW APPEARS SIMULTANEOUSLY AT THE INPUTS AS SHOWN. DETERMINE THE OUTPUT OF EACH OF THESE ARRANGEMENTS:

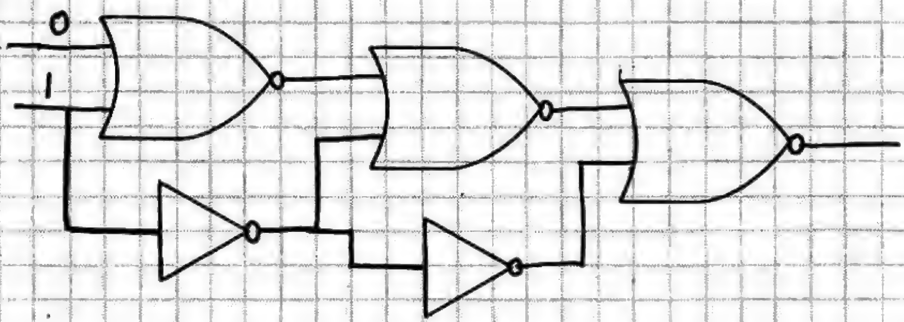
1.



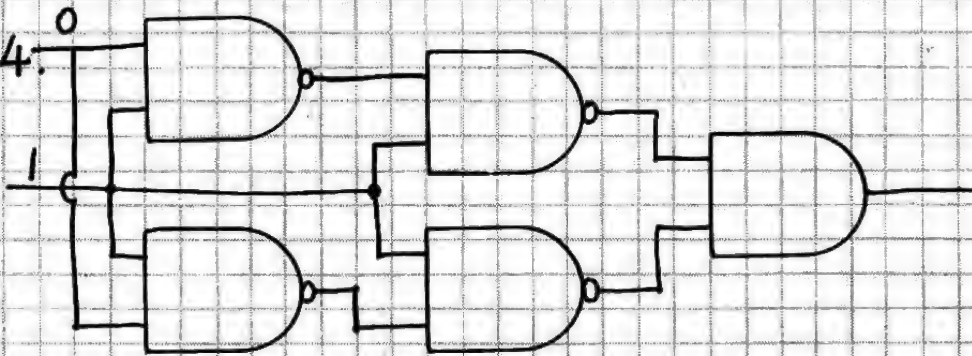
2.



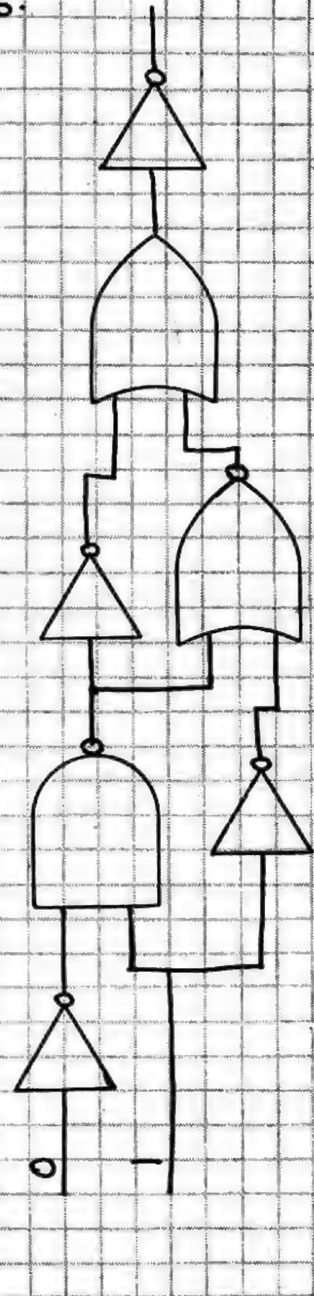
3



4.



6.



5. (a) DRAW 2 <u>NAND</u> GATES AND WIRE THEM TO FORM AN <u>AND</u> GATE.

(b) DRAW 2 <u>NOR</u> GATES AND WIRE THEM TO FORM AN <u>OR</u> GATE.

(c) HOW DO YOU CONNECT A <u>NOR</u> GATE TO FORM A <u>NOT</u> FUNCTION?

1:0 2:1 3:0 4:0 6:0

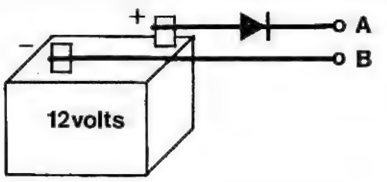
TEST YOURSELF... No 3

How good are you at identifying diodes? This quick test will give you a rating

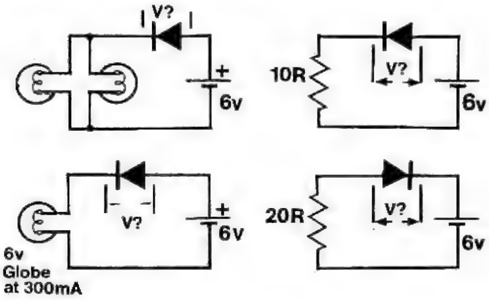
DIODES..

A DIODE may look an innocent 2-leaded package yet underneath the bland external appearance lies the first electronic component ever to be discovered. Even though it cannot amplify it is capable of performing over 12 different functions. We will consider only 3 of these in this test:

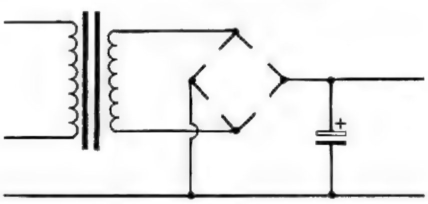
1. What is the voltage between terminals A&B?



2. What is the voltage across the diode in each of these circuits?

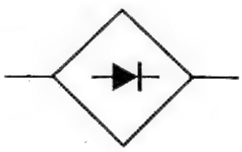


3. Draw a FULL-WAVE RECTIFIER BRIDGE:



4. When we measure a diode with a multimeter which has been set to "ohms" scale, we find its forward resistance reads about 20 ohms and when connected around the opposite way, has a reverse resistance of about 300k. What is the needle really telling us?

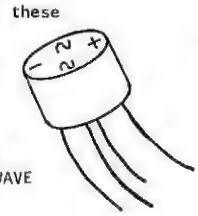
5. Why do some circuits show a FULL-WAVE BRIDGE RECTIFIER as:



6. A FULL-WAVE RECTIFIER package has these symbols marked on the top:

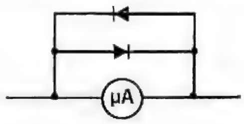
(a) Match-up the identifying symbols on the top of the package with the four leads emerging from the base of the rectifier.

(b) Place the symbols as per the top of this rectifier onto the FULL-WAVE RECTIFIER diagram shown in Q.3.

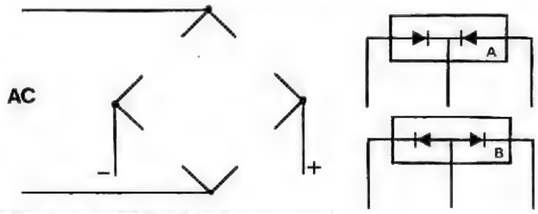


7. When measuring a diode on a multimeter set to "Ohms x 1" scale, the reading is about 20ohms. Adjusting the range to "ohms x 1k", the forward reading is 10k ohms. Explaing this.

8. Explain how the shunt diodes protect the micro-ammeter movement.



9. Fit these 2 diode packages into the circuit diagram to create a FULL-WAVE RECTIFIER.

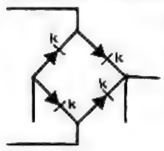


Answers

1. 12v - .6v = 11.4v Subtract .6v for any forward-biased silicon diode.

2. .6v appears across each diode except the fourth circuit. This diode is reverse biased and the full 6v appears across it.

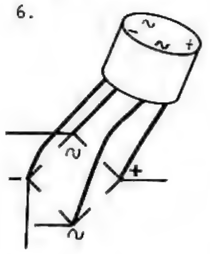
3. When drawing a bridge, remember the cathodes of the two right-hand diodes connect to the positive of the electrolytic and the anodes of the two left-hand diodes connect to ground.

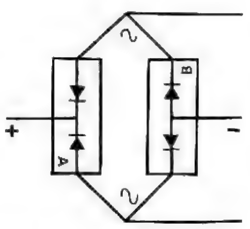


4. The ohm-meter is really measuring a fraction of the voltage of the battery contained in the meter and this deflects the needle to full scale. Placing a diode in circuit with the leads effectively reduces this voltage by .6v and the needle responds accordingly. The same reading would be obtained if we presented a .6v supply in place of the diode.

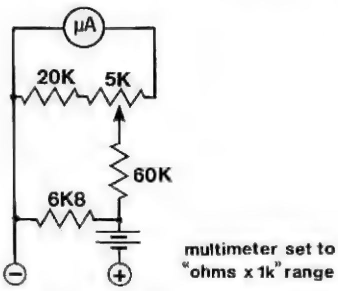
5. A simplified schematic to show the general direction of the 4 diodes.

6.





7. On the "ohms x 1k" scale, the multimeter has seen the diode as a .6v loss and the needle has deflected to the 10k position. Do NOT read this as 10k, just as a deflection.



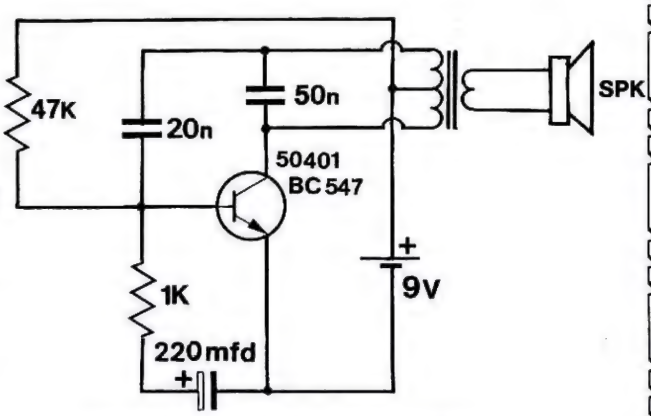
8. The diodes do not turn on until about .6 of a volt appears across them. Below this voltage they are an open circuit as far as the movement is concerned. This means that no more than .6v can appear across the movement and it cannot be drastically over-loaded.

Score

We have not given a score for this test. Give yourself a fail or pass mark and enter the value here:____%

SINGING BIRD

The SINGING BIRD circuit is basically a blocking oscillator which is turned on and off at a slow frequency to give the effect of a chirping bird. The circuit looks very simple but needs some intensive explanation for you to fully understand its operation. This circuit form the basis of many of the kits and with a re-arrangement of parts, will produce a number of different sounds. Firstly we will consider the circuit as shown, minus the 1k resistor and 220mfd electrolytic. If we were to make this circuit it would oscillate at a fairly high frequency. It forms a blocking oscillator circuit in which the transformer performs a dual role. The primary of the transformer is centre-tapped. Signal-wise, this centre tap is a neutral point. When a signal flows through the lower half of the primary, it appears at the top of the primary with reverse polarity. Even though this winding is connected to the lower half via the centre tap, the voltage produced by it is derived purely by transformer-action. This occurs via the building-up and collapsing magnetic field inducing a voltage in the winding which is slightly delayed in time. We make use of this delayed voltage and feed it back to the base of the transistor via the .02 mfd capacitor. The 47k resistor provides bias to turn the transistor on. This covers every part in the circuit. When the battery is connected, the 47k resistor provides bias to turn the transistor on. This puts a heavy current through the lower half of the transformer and after a short time delay a signal of reverse polarity appears at the top of the transformer. This is fed to the base of the transistor via the .02mfd capacitor and turns it hard off. This is only a spike of short duration and soon the bias provided by the 47k resistor turns the transistor on again. The frequency of oscillation is determined by a combination of all the components we have listed including the effect of the speaker as a load on the transformer. When we add the 1k resistor and 220mfd electrolytic, not only do they alter the frequency dramatically, but they create the characteristic chirping of the oscillator. They effectively turn the oscillator on and off by the following method: The 220mfd electrolytic gradually charges via the 1k and 47k resistors and when the base voltage approaches about .8v, the oscillator turns on. It oscillates for a fraction of a second and in doing so, the spikes through the .02mfd capacitor are rectified by the base-emitter junction of the transistor and appear as a negative voltage to discharge the electrolytic. The voltage falls to below .6v and the oscillator turns off. The cycle then repeats itself.

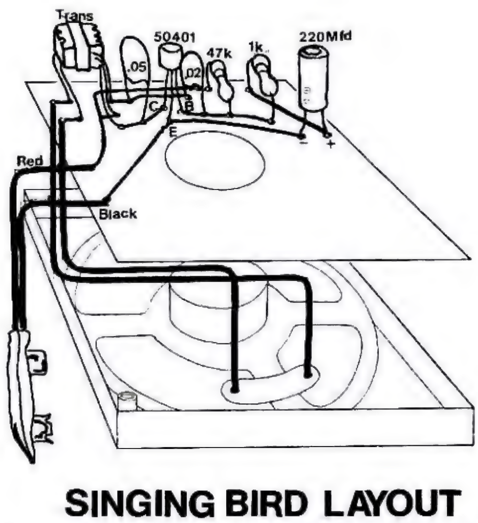


SINGING BIRD CIRCUIT

You can make this circuit from the kit or use any old transistor radio components. The wiring of the speaker transformer primary will have to be watched to make sure feed-back takes place. The transistor can be any NPN type, similar to BC 547.

EXPERIMENTS: Three interesting experiments can be performed with this project:

1. Remove the 220mfd electrolytic and notice the change in frequency.
2. Connect another 220mfd electrolytic across the battery leads where they enter the PC board. Disconnect the battery and notice the change in frequency as the voltage dies down.
3. Touch the .05mfd capacitor with a warm soldering iron while the oscillator is functioning. Can you see why we don't use this type of capacitor in high-stability oscillator circuits?

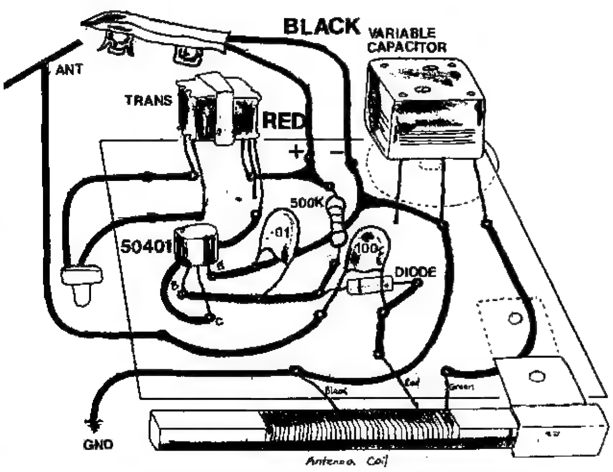


SINGING BIRD LAYOUT

RADIO

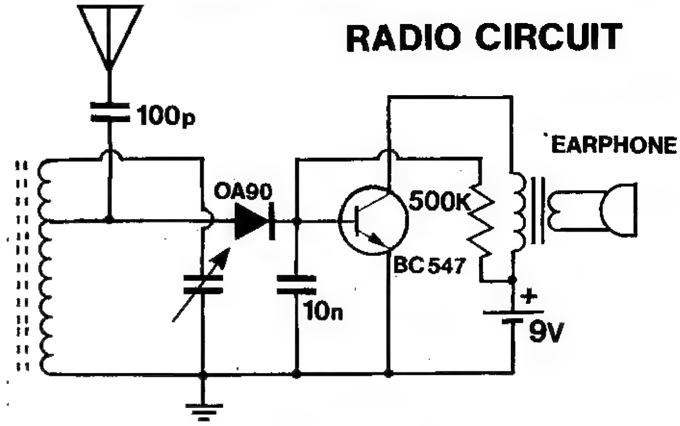
The RADIO KIT is really a crystal set with a one transistor amplifier. The signal is picked up by the aerial and fed to the tuned circuit consisting of the aerial coil and tuning capacitor. This RF signal is passed to the diode where it is converted to an audio frequency signal. This is fed to the base of the transistor which amplifies it about one hundred times to make it loud enough to hear in comfort. The transistor is coupled to the low impedance earpiece via a small transformer The transformer provides impedance matching and allows the transistor to maintain a high voltage swing with low current flow whereas the earpiece requires a higher current flow and needs only a small voltage swing.

For this "RADIO" project to work properly you will need an aerial and an earth. Ideally the aerial should be about 10 to 20 metres long and as high as possible. This usually involves taking up the whole of the back-yard with a high "clothes-line", but if this is a bit impractical, you can try the metal of the telephone dial or your TV antenna. For an earth you can use the cold-water tap or the frame-work of the sink. Don't expect to get fantastic results because we didn't! We didn't get very good station separation either. In fact we only got one station at the low frequency end of the band. Maybe you will get better results with a good aerial, but if not, don't despair. The components from this project will be handy when we build a simple 3 or 4 transistor TRF radio which will be a portable type.



RADIO LAYOUT

RADIO CIRCUIT

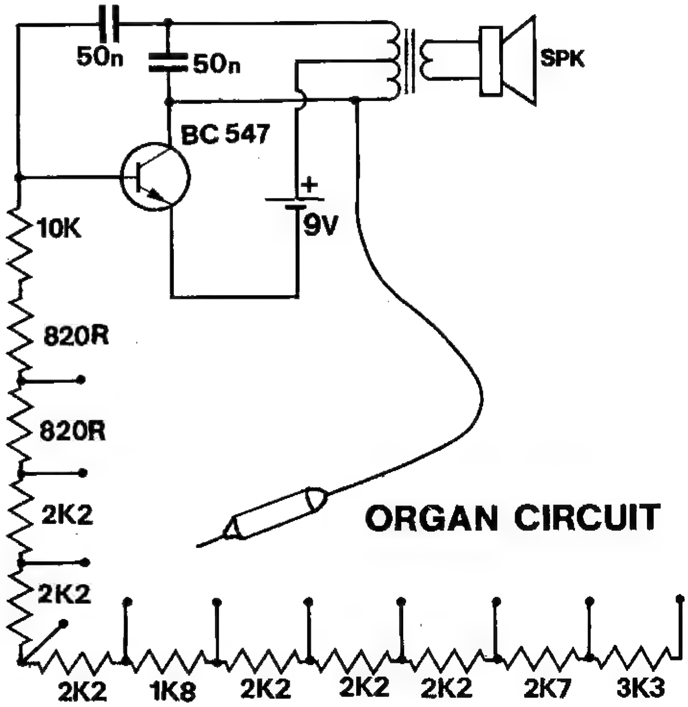


ELECTRONIC ORGAN

This circuit is identical to that of the SINGING BIRD. It is a blocking oscillator circuit in which a chain of resistors is used to modify the base bias. It does not matter whether the probe lead is taken off the centre tap of the transformer or either end, it is purely providing a DC bias.

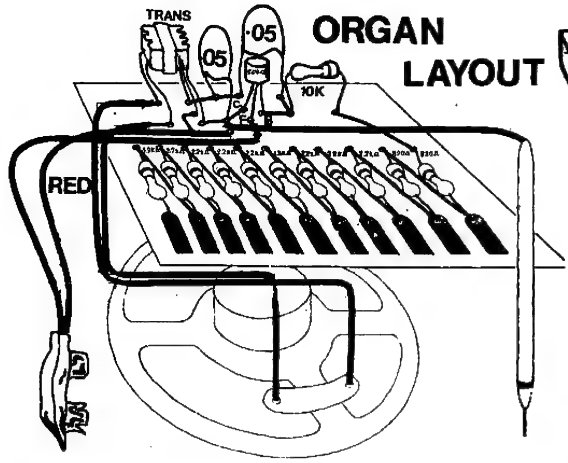
The scale of this organ has quite a useful range and simple tunes can be played on the copper side of the board as it is etched in the form of a simple keyboard. This is quite a neat little toy and is normally more expensive than the other kits and so provides good value as well as hours of fun.

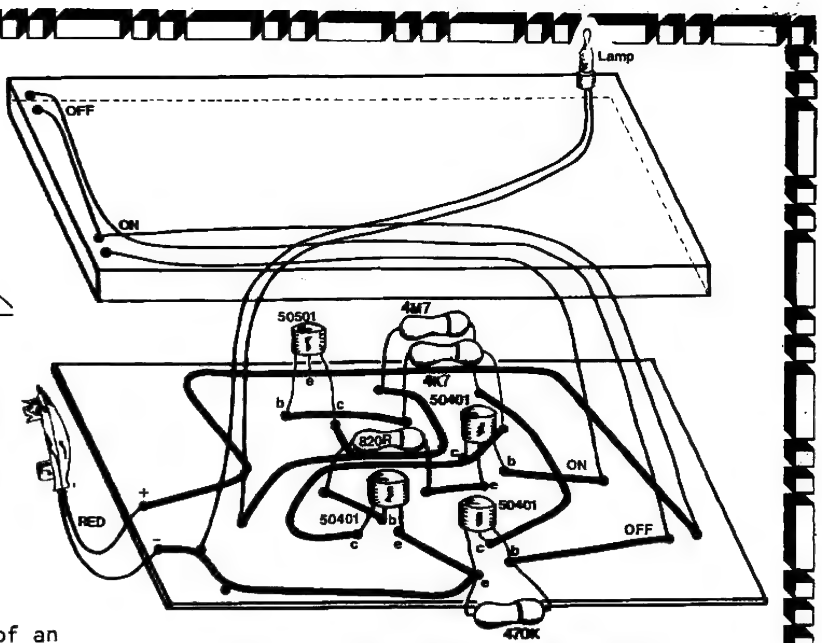
Try tapping the probe on the end of the other components and even put your fingers on the copper side of the board. You will be surprised at how many other sounds can be generated.



ORGAN CIRCUIT

ORGAN LAYOUT





TOUCH SWITCH LAYOUT

TOUCH SWITCH

The TOUCH SWITCH circuit consists of 4 transistors and a small globe. In place of an ON-OFF switch is a set of 4 studs and the circuit makes use of the resistance of the skin of your finger to turn the globe ON and OFF. When the battery is connected, the globe will be extinguished. Touching the ON terminals will provide a voltage of about 2v on the base of Q2. The reason why this voltage must be over 1.2v is due to Q2 and Q3 being arranged as a super-alpha pair. It provides very high gain with very high input and requires few components. To turn Q2 ON, we have to provide the base-emitter voltage for Q2 as well as Q3. When these turn on they provide a forward bias for Q4 via the current limiting resistor:4k7. When Q4 turns on, the collector-emitter voltage falls to about 1v and the lamp is provided with near-supply voltage. This 8v is also supplied to the 4M7 resistor and since we said the input impedance of the super-alpha pair is very high (Q1 can be effectively neglected in this part of the discussion) the resistor will provide enough forward voltage to keep the three transistors turned on when your finger is removed. The 4M7 resistor is called a feed-back resistor.

Now let us deal with the off section. Q1 is effectively biased off via the 470k resistor but when you put your finger on the OFF studs, the transistor will turn ON. This will reduce its collector-emitter voltage to about 1v, which is less than that required to keep the super-alpha pair turned ON and thus the globe will be extinguished.

You will notice this circuit has a fairly rapid snap action due to the 4M7 feedback resistor.

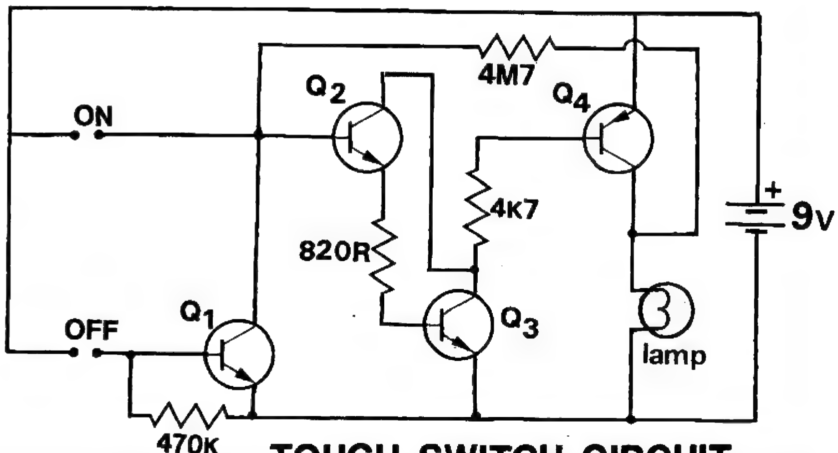
If you find the globe to be fairly dull on 9v you can safely increase the supply to 12v. The globes supplied are actually 12-15v @200ma.

The quiescent or standing current of this circuit is only about .7ma so a large 6v battery such as 509, can be left connected for about 12 months.

We will be able to think up lots of ideas for this type of circuit so it would be wise to make up one of these circuit and see first-hand how they work.

TRANSISTOR EQUIVALENTS

CS9013=E50301=BC547 NPN
CS9014=E50401=BC547 NPN
CS9015=E50501=BC557 PNP



TOUCH SWITCH CIRCUIT

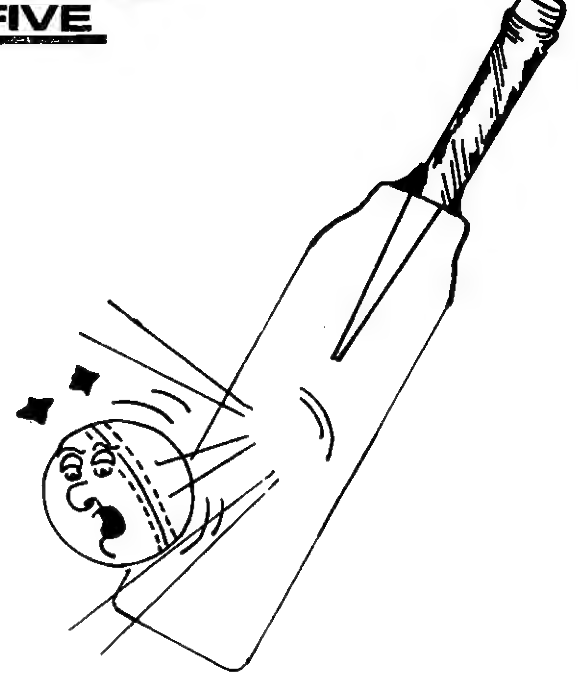
....Continuing our series on the

EXPERIMENTER DECK

CRICKET GAME

PROJECT FIVE

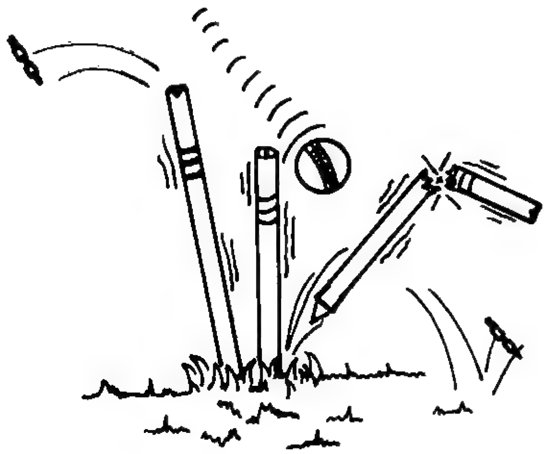
The three projects this month use the same circuit... The RUNNING LIGHT circuit.
We adjust the speed of the decade counter to suit each project.



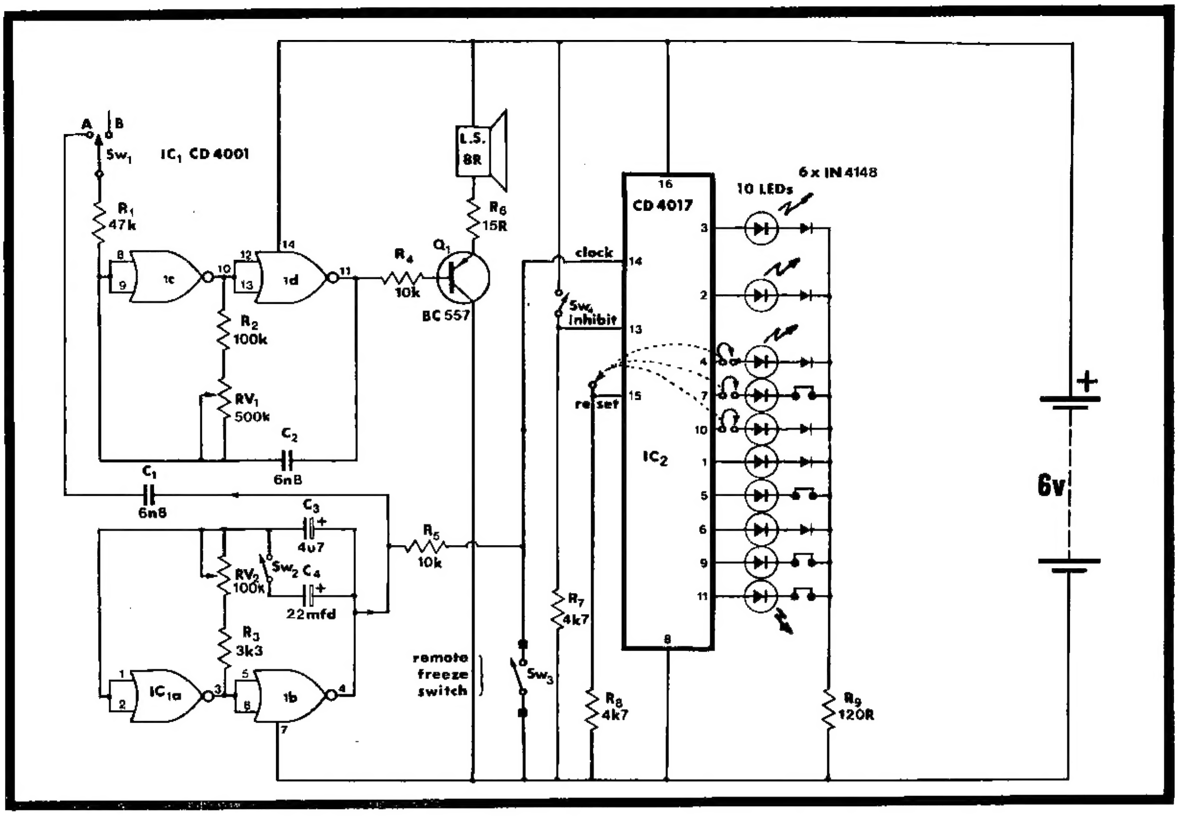
The complete circuit for this month's three projects has already been fitted to the PC board. You will only need to wire in a switch for the second player to make the running light into a cricket game. This means, by adjusting the pre-settable jumpers you will be able to operate the running light in three different modes. This will create three different effects. Not exactly completely different but a variation in presentation. These three projects are designed for two players and you will be able to match your reaction time with that of your friends. And you will be able to do it digitally.

PARTS

1 - Push-to-make switch.



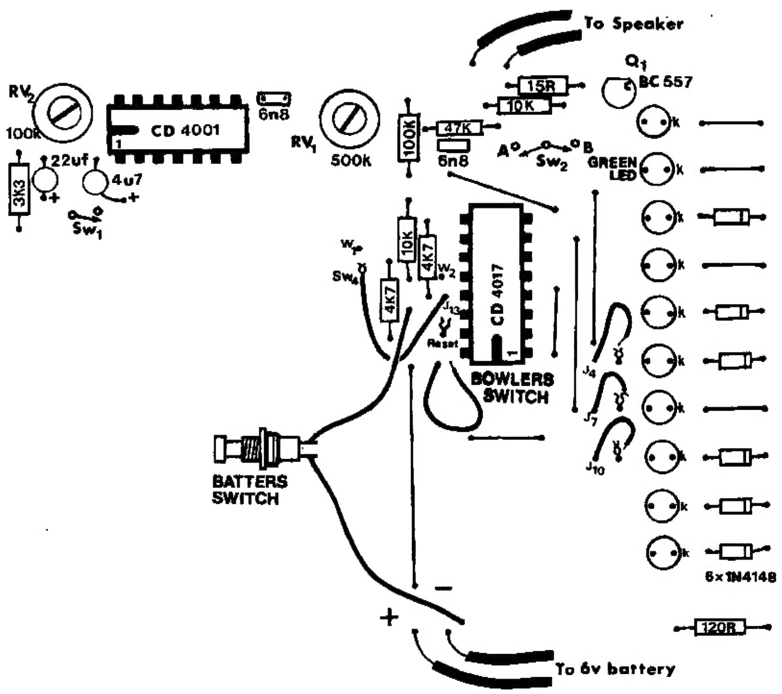
PROJECT FIVE IS A CRICKET GAME. It's only a simple, basic game with scope for improvements such as a fancy box, coloured decals and even miniature figures playing cricket with toy wickets and bat. One player becomes the batsman. He holds the BATTERS SWITCH. The BOWLER uses the jumper on the Experimenter Deck to reset the counting IC to zero. On the circuit diagram the BATTERS SWITCH is labelled "remote freeze switch" and is connected to the circuit at the negative terminal and pin 14 of the CD 4017. A square solder land is provided at these two positions for the switch. The switch "shorts out" the incomming pulses from the CD 4001 and prevents them entering the CD 4017. A 10k resistor separates this short from the CD 4001 to prevent it being damaged.
The game commences when the bowler removes his jumper from pin 15. This clocks the CD 4017 and the LEDs begin to run towards the wicket. The batsman attempts to hit the ball when the green LED is illuminated. If he pushes his switch and freezes the action on the green LED, it is counted as a run. Normal scoring can be used with the winning player gaining the highest score before being bowled out. The very last LED indicates a fallen wicket. If this lights, the batsman is "bowled" and players change positions.



Cricket Circuit (AND TIMER, AND REFLEX)

With slight additions and alterations the RUNNING LIGHT circuit becomes a cricket game. The reset jumpers from LEDs 3, 4 and 5 are returned "HOME". The re-setting is now done from the positive line where you will be able to reset the IC at any instant to begin each game from LED number 1. The switches can be improved and mounted into separate boxes to allow the batsman and bowler to gain better control of the action.

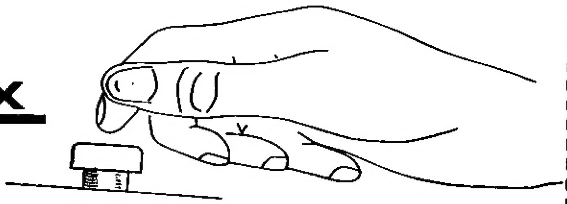
The 10k pot is adjusted to give the speed of the ball. As the competence of the players increases, the speed can be increased. To gain co-ordination between players, I suggest running the ball at a fairly slow speed at the beginning and working up to the impossible rate where the pot is fully closed.



CRICKET LAYOUT

TIMER

PROJECT SIX

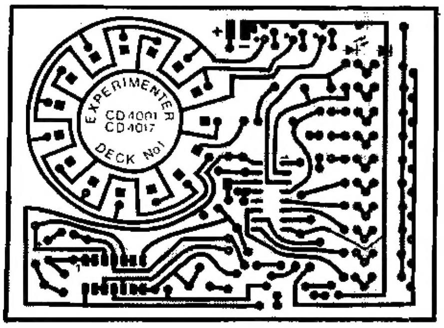


What is the use for a "LIGHT-TIMER" or a "SOUND-TIMER?"

Production-line assembly work quite often requires a sound to indicate the end of an operation. This allows the workers eyes to be kept free to concentrate on the operation. The same applies to photographic work. The operator cannot afford to take his eyes off the development process and since the level of illumination in a dark-room is low, it would be difficult to see a clock.
In fact any routine assembly or manufacturing process could utilize an audible alarm. This project provides a suitable basis for a handy timer that gives an audible as well as light readout. It is capable of timing from one second to about 40 seconds. With alterations to the timing capacitor and resistor, it can be extended to about 2 minutes. However, as it stands, it is only capable of a short time delay. Since there are 10 LEDs, a visual record of time elapsed can be seen during the delay. This means the audible and visual facilities can be used in conjunction so that full concentration can be awarded to the operation in hand.

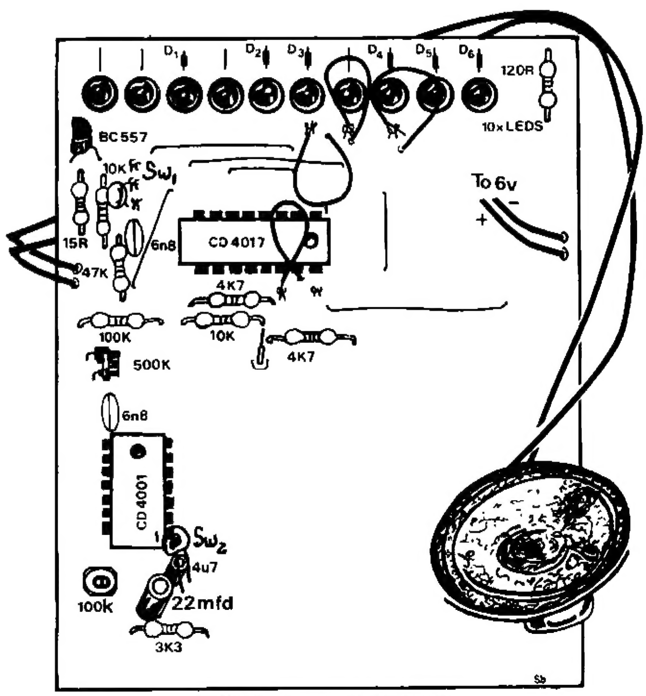
HOW THE CIRCUIT WORKS

Basically it is a running light circuit slowed down to about 2 seconds per flip and 2 seconds per flop. The CD 4017 counting IC only counts after each flop so you will hear a high and a low note while each LED is lit, making a total time of 10 x 4 seconds or about 40 seconds. To create a universal timer for time delays up to 2 minutes or more, it would be necessary to change the 100k mini trim pot to a 500k mini trim pot in conjunction with a 10mfd tantalum capacitor. Since time delays over 5 seconds per cycle become unreliable with this type of circuit when using a low voltage, it is not recommended that you try to extend the cycle over 5 seconds. However as time delays up to 2 minutes can be achieved, you will be able to achieve time intervals of 4 or 6 minutes by repeating the sequence.



Shaded area covers the soldering for projects 1-7.

Adjust the 100k mini trim pot to give 2 seconds per flip and 2 seconds per flop. You can experiment with longer time intervals but you will find a point will be reached where the IC will not have a guaranteed start. The molex-pin switch Sw_1 will give you this longer time delay by bringing the 22mfd capacitor into circuit.
Even longer time delays are possible with the CD 4001 IC, however this involves a different circuit which does not "cycle".



TIMER LAYOUT

TEST YOUR REFLEX TIME

PROJECT SEVEN

Catch up with the New Decimal time

When driving a car we pride ourselves as having an "instant reflex" to avoid danger. When walking down the street we may duck away from the appearance of a foreign missile coming towards our eyes. We may think these are instantaneous reactions but they must take some fraction of time, no matter how short. In fact, the reason for our eyelashes is not to promote mascara but protect our eyes from flying objects. Our eyelids are capable of closing as soon as the eyelashes detect an impulse and cover the eyes before the object has time to travel the last centimetre.

Some parts of our body have a very fast reaction-time, others are much slower. The reflex-time we are interested in involves our "eyes-brain-hands" co-ordination.

We test it in this manner:

The RUNNING LIGHT circuit is set up to time to 1/20 second. To achieve this, the CD 4001 must oscillate at 20Hz so that in one second it will clock the CD 4017 20 times. This will run the LEDs twice down the row and gives the following table for each LED:

LED	TIME
1	0 sec
2	.05 sec
3	.1 sec
4	.15 sec
5	.2 sec
6	.25 sec
7	.3 sec
8	.35 sec
9	.4 sec
10	.45 sec

To obtain an accurate 20Hz frequency you will need an ordinary watch with a seconds hand. Adjust the 100k pot and count the number of times the 10th LED lights up. When it blinks 20 times you have a 20Hz oscillator. Use this frequency to clock the CD 4017. The object of this game is to freeze the LEDs as soon as possible after they begin to run. Two players will be needed, one to start the LEDs running while the opponent attempts to freeze the motion. Since the first LED must be lit to commence timing, each additional LED represents .05 seconds.

We conclude this series next issue with the most interesting section...making music. We will be adjusting the frequency of an oscillator by adding capacitance to the input circuit and clocking these capacitors at a set rate or a variable rate to give different effects. This will be the beginning stages of the purpose of our **very existence.** As our name conveys, we will be introducing the ultimate in electronics... that of talking modules. These all rely on a generated sound and in gradual stages we hope to achieve simulated sppeeecch.

Quiz: You must answer these questions, otherwise don't buy issue 4.

These items were introduced in this issue. Describe their function:

1. 7805:

2. CD 4024:

3. EM 401:

4. Explain in 6 lines how we "one shot" a 555.

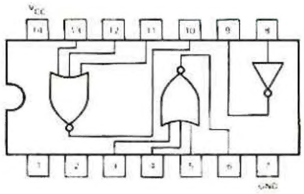
5. Explain in 4 lines how a Bridge Rectifier changes 50 Hz to D.C.

6. What is the difference between a 7805 and a 7812 voltage regulator?

DATA

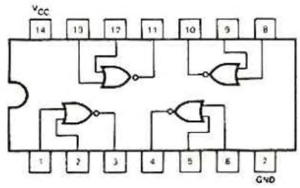
Sheet No.3.

CD4000



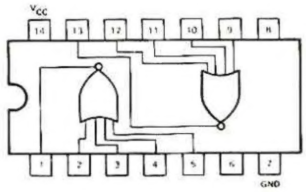
DUAL 3-INPUT NOR GATE PLUS INVERTER

CD4001



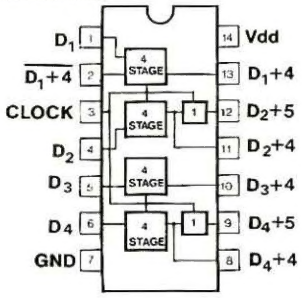
QUAD 2-INPUT NOR GATE

CD4002



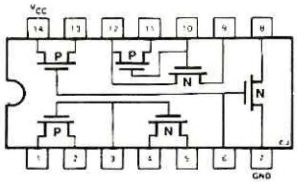
DUAL 4-INPUT NOR GATE

CD4006



18-BIT STATIC SHIFT REGISTER

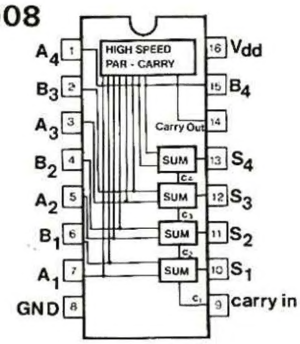
CD4007



All P Channel Substrates Connected to Vcc
" N " " " " " GND

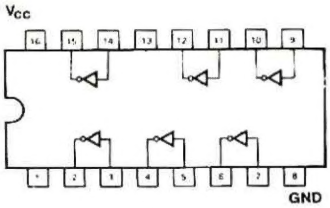
DUAL COMPLEMENTARY PAIR PLUS INVERTER

CD4008



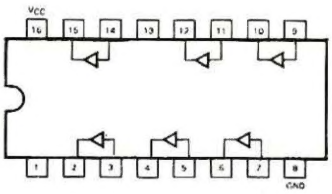
4-BIT FULL ADDER WITH PARALLEL CARRY

CD4009



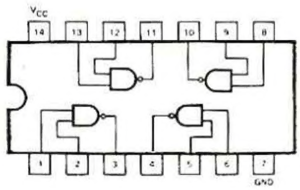
HEX BUFFER (INVERTING)

CD4010



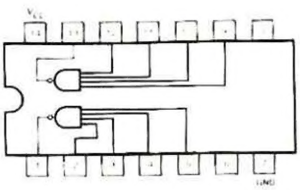
HEX BUFFER (NON INVERTING)

CD4011



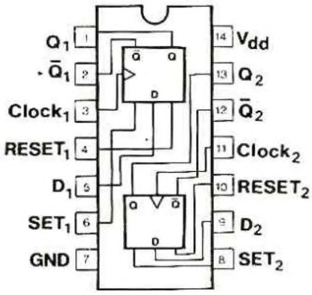
QUAD 2-INPUT NAND GATE

CD4012



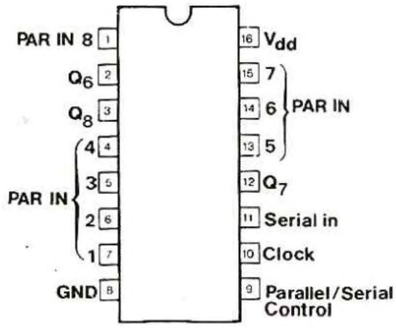
DUAL 4-INPUT NAND GATE

CD4013



DUAL D FLIP-FLOP

CD4014



8-BIT STATIC SHIFT REGISTER

CPW

TALKING ELECTRONICS IS DESIGNED AND PUBLISHED AT 35 ROSEWARNE Ave, CHELTENHAM 3192 550 2386 584 2386 ©1981